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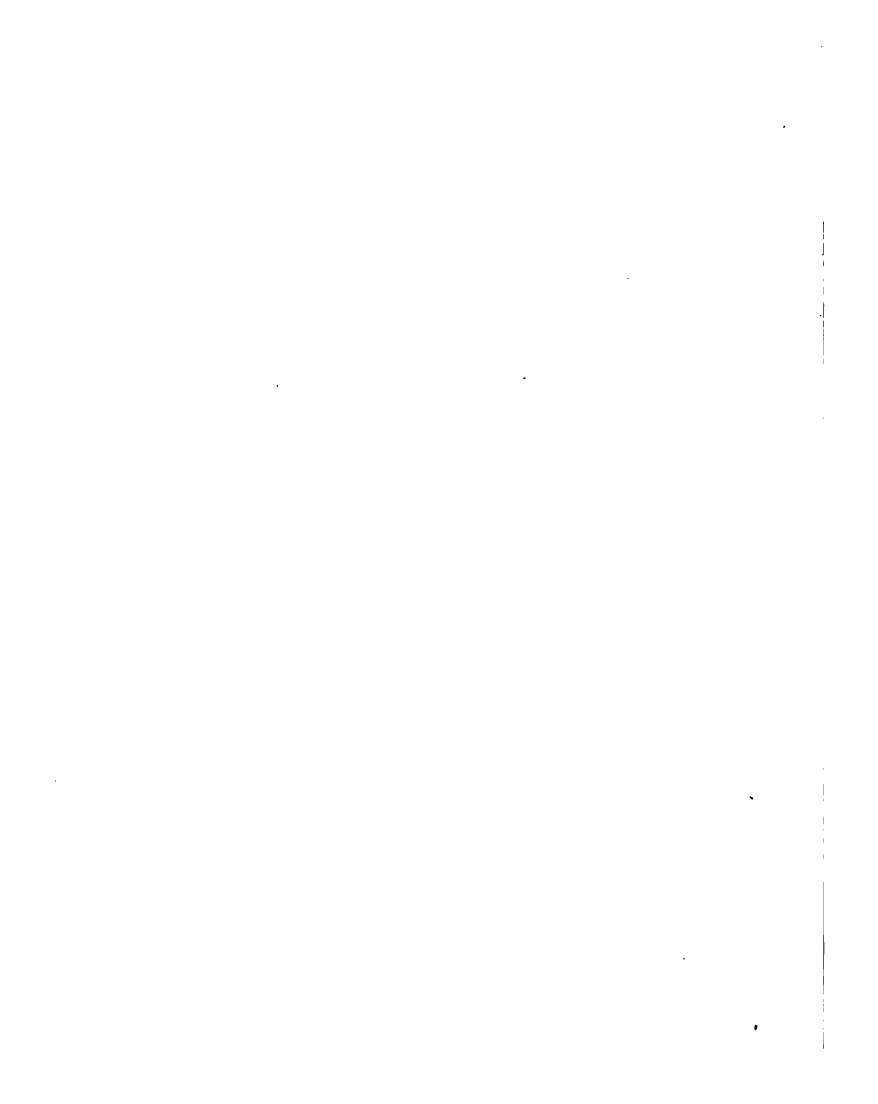
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PASSAGE OF THE ST. LAWRENCE IN WINTER. (*See p. 26.*)

THE
FROZEN STREAM;
OR,
An Account
OF
THE NATURE, PROPERTIES, DANGERS
AND USES OF ICE,
IN VARIOUS PARTS OF THE WORLD.

PUBLISHED UNDER THE DIRECTION OF
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THE FROZEN STREAM.

CHAPTER I.

GENERAL EFFECTS OF FROST—AN ENGLISH WINTER—A RUSSIAN WINTER—DANGERS OF EXTREME COLD—ADVENTURE OF SIR JOSEPH BANKS AND DR. SOLANDER IN THE MOUNTAINOUS DISTRICT OF TERRA DEL FUEGO—THE FREEZING OF THE ST. LAWRENCE—DANGEROUS PASSAGE OF THE RIVER—THE SETTING OF THE ICE—FROZEN RIVERS THE HIGH ROADS FOR TRAVELLERS—POWER OF THE LOWER ANIMALS TO ENDURE COLD—EFFECTS OF COLD IN GREENLAND.

“An icy gale, oft shifting, o’er the pool,
Breathes a blue film, and in its mid career
Arrests the bickering stream. The loosen’d ice
Let down the flood, and half dissolved by day,
Rustles no more; but to the sedgy bank
Fast grows, or gathers round the pointed stone,
A crystal pavement, by the breath of Heaven
Cemented firm; till, seized from shore to shore,
The whole imprison’d river growls below.”

Thomson.

IN the dark short days of winter, when chilling rains or freezing blasts drive us to places of shelter and of warmth, when all nature lies desolate and apparently dead, and the voice of birds and

the hum of insects are heard no more ; we might naturally suppose that the earth itself had partaken of that torpor, or deep sleep, into which many animals fall at the approach of winter. But the case is very different. Underneath the frozen surface, a great work is proceeding ; even a preparation for the coming spring ; and the more steady and continued the frost, the better probably will that work go on, and the richer will be the productions of the year.

“ All nature feels the renovating force
Of winter, only to the thoughtless eye
In ruin seen. The frost-concocted glebe
Draws in abundant vegetable soul,
And gathers vigour for the coming year.”

Meanwhile, the effects of frost are seen and heard in every direction. The borders of the river are fringed with icicles, and the overhanging boughs seem changed into stone.

“ The crystal drops
That trickle down the branches, fast congeal'd,
Shoot into pillars of pellucid length,
And prop the pile they but adorned before.
Here, grotto within grotto safe defies
The sunbeam ; there, embossed and fretted wild,
The growing wonder takes a thousand shapes
Capricious, in which fancy seeks in vain
The likeness of some object seen before.”

The frozen fields are as firm beneath the feet as the high road, and not even the sharp bill of the rook can dig up the roots or worms that lie buried there. The berries of hawthorn and holly look bright in the hedges, and supply food to many birds, without which they would certainly perish: hence it is reckoned by country people as a sure sign of a hard winter, when these berries are abundant. As the frost gains strength, the woods and copses, as well as the open fields, become crusted with ice: no longer, therefore, can their fleet inhabitants find enough to support life. Timid hares and rabbits venture into gardens by night, and feed on vegetables and the bark of young trees. Small birds crowd to the rick-yard, and to the eaves of houses; and one, the familiar robin, taps at our windows, or enters our dwellings, to receive food at our hands.

The foot-path is firm as a rock, and the highway rings to the tread of horses and men. All sounds come clearly through the frosty air: the baying of the village dog, the lowing of cattle, or the footsteps of travellers, can be heard to a great distance. The influence of a wintry sun has little power over the frozen earth, and the day soon

closing in, leaves the power of frost to strengthen itself during the night, and to bind in stronger chains the meadows, the forests, and the streams.

How beautifully the hand of winter adorns our windows with frost-work. The moisture of the room, attracted and condensed by the cold, slowly and silently arranges itself into various feathery and leafy forms.

The heavens shine out through the cold, clear, frosty air, with a magnificence unseen at any other part of the year. The stars appear larger and more brilliant than usual; the principal constellations seem to approach nearer to the earth; the milky way stands out like a bright path in the sky, and now and then a shooting star, or other bright meteor, leaves a long trail of light to mark its track. Meanwhile,

“From pole to pole the rigid influence falls
Through the still night incessant, heavy, strong,
And seizes nature fast. It freezes on;
Till morn, late-rising o’er the drooping world,
Lifts her pale eye unjoyous.”

The icy hand of winter has now frozen up the ponds, brooks, and smaller streams; and ere long, rivers and canals will be also frost-bound, leaving



APPEARANCES OF FROST ON WINDOW-PANES.

bargemen and watermen without employment, and tempting forth the crowd of skaters to their favourite diversion.

Such is our winter in its severest mood ; but the cold of this climate is slight compared with that of many other countries, and the dangers of the ice are scarcely to be named in comparison. Accidents indeed happen every year to foolish persons who mistake rashness for courage, and who venture on the ice before it is strong enough to bear their weight ; but to any one possessed of common prudence, the ice is perfectly safe, and affords a delightful means of exercise and amusement.

In order to see the effects of frost, and the real dangers connected with it, we must look beyond our own favoured country, to those which are situated further north, or in the midst of vast continents, where the cold exerts a greater influence than in an island like Britain, which is protected by the waters of the ocean.

The severity of a Russian winter so far exceeds anything we have had experience of, that the accounts of travellers and of English residents in that country appear marvellous. For instance,

we could scarcely believe that a piece of apple-peel thrown from a window in Moscow, should freeze to a ledge which it happened to touch in its fall, and there remain ice-bound until a thaw, seven weeks afterwards, enabled it to finish its journey to the ground. Yet this is one of the instances given by a recent traveller of the severity of the winter in that city. When the cold is thus severe, persons who are obliged to be much in the open air, are in great danger of becoming frost-bitten, or of having their fingers, nose, ears, or eyes frozen, and apparently converted into marble; or, if the cold be extremely severe, they are liable to be overcome with sleep, and sink down in a fatal slumber, from which they never awake. The earliest symptoms produced by the cold, are as follows:—The hands, ears, nose, and lips, assume a reddish blue colour; the skin shrinks so as to resemble the surface of a plucked goose; the same state of the skin of the scalp often causes the hair to rise in some degree from the head, with a feeling of tightness. The fingers, toes, ears, and nose, suffer first, because these are furthest from the heart. The fingers and toes become sensibly smaller, so that rings which fitted before, fall from the

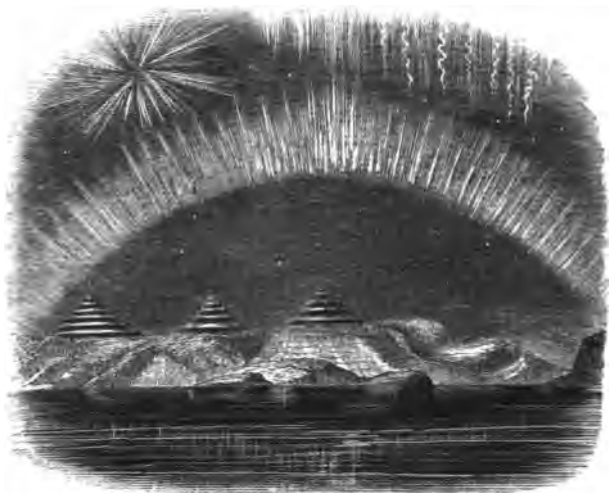
fingers, and shoes drop off from the feet for which they were not previously too large. The action of the heart is diminished in force, but the pulsations are more frequent than usual.

In St. Petersburg the winter begins in October, and ends in May. On the first appearance of frost, every man puts on his furs, and does not think of laying them aside until winter is quite gone. The stoves are lighted in every house, and no room is allowed to get cool. When the temperature is so low as about 12° or 14° below zero, every one carefully watches the thermometer. At about -20° the police are on the alert, and the officers go round day and night, to see that the sentinels keep awake. Should any one be found nodding at his post, he is immediately and severely punished, for sleep at such a time is certain death. Public amusements are given up, because coachmen and servants waiting in the streets are liable to be frozen to death. Foot passengers, who at other times are rather leisurely in their movements, now keep up a brisk pace, and sledges dash rapidly over the creaking snow. A very small part of the face is to be seen in the streets, for every man draws his furs over his head, and shows but

little of his countenance. Every one is uneasy about his nose and ears, which are very apt to get frozen; and as the sufferer is not aware of his danger by any previous uncomfortable sensation, the first person in the street who observes a nose putting on the appearance of white marble, exclaims, "Sir! sir! Your nose! your nose!" and taking up a handful of snow, applies it to the stranger's face, and endeavours, by briskly rubbing, to restore the circulation. These are salutations which people are accustomed to in such climates, and by which thousands of these valued organs are saved from the clutches of the frost. A man's eyes also at this season cost him some trouble, for they are apt every now and then to freeze up. On such occasions, it is customary to grope the way to the door of the first house, and ask permission to sit for a few minutes by the stove. This is never denied, and the stranger, by way of gratitude, seldom fails to leave a thawed tear upon the hospitable floor.

Further north, while the heavens are glittering with the light of the Aurora Borealis, the dangerous effects of frost are even more remarkable. When Captain Parry wintered on Melville

island, the frost bites were sometimes so severe, that fingers, and even hands and feet, had to be amputated by the surgeon—so completely were



AUROMA BOREALIS.

The scene is in the vicinity of the Three Crowns, on the coast of Spitzbergen.

they *killed* by the cold. To touch any metallic substance with the naked hand, produced the sensation and effect of red-hot iron, by taking the

skin off the hand. The eye pieces of telescopes, if suffered to touch the face, occasioned an intense burning pain ; but this was easily remedied by covering them over with soft leather. But the most formidable effect of intense cold is that produced on the brain : this organ loses its energy, a sense of numbness creeps over the whole surface of the body, and an irresistible desire to sleep comes on, which, if indulged, generally ends in death.

The effects of cold upon the human frame are well illustrated by the account given by Captain Cook of the excursion of Dr. Solander and Sir Joseph, then Mr. Banks, with nine other individuals, who went on a botanizing excursion over a portion of the mountainous district of Terra del Fuego, the southernmost extremity of South America.

While the party were on the mountains, the weather, which for some time had been very fine, became gloomy and cold, with sudden blasts of a most piercing wind, accompanied by snow. The day was so far spent that it was impossible to get back to the ship before the next morning, and they were obliged to pass the night on the mountain. They therefore pushed on towards a

more sheltered spot, where they might kindle a fire and build a wigwam. It was now near eight o'clock in the evening, says the narrative, but still good day-light; and they set forward for the nearest valley, Mr. Banks himself undertaking to bring up the rear, and see that no straggler was left behind. Dr. Solander, who had more than once crossed the mountains which divide Sweden from Norway, well knew the dangers of extreme cold; he therefore conjured the company to keep moving, whatever pain it might cost them, and whatever relief they might be promised by an inclination to rest. "Whoever sits down," said he, "will sleep; and whoever sleeps, will wake no more." Thus at once admonished and alarmed, they set forward; but while they were still upon the naked rock, and before they had got among the bushes, the cold became suddenly so intense as to produce the effects that had been most dreaded. Dr. Solander himself was the first to be seized with the fatal inclination against which he warned others, and insisted upon being suffered to lie down. Mr. Banks entreated and remonstrated in vain; down he lay upon the ground, though it was covered with snow, and it was with great difficulty that his

friend kept him from sleeping. Richmond, also, one of the black servants, began to linger. Mr. Banks therefore sent five of the company forward to get a fire ready at the first convenient place they could find; and himself, with four others, remained with the doctor and Richmond, whom, partly by persuasion and entreaty, and partly by force, they brought on; but when they had got through the greatest part of the birch and swamp, they both declared they could go no further. All that Mr. Banks could say produced no effect: when Richmond was told that if he did not go on, he would in a short time be frozen to death, he answered, that he desired nothing but to lie down and die. The doctor was willing to go on, but said that he must first take some sleep, though he had before told the company that to sleep was to perish. Mr. Banks and the rest found it impossible to carry them; and there being no remedy, they were both suffered to sit down, being partly supported by the bushes; and in a few minutes they fell into a profound sleep. Soon after, some of the people who had been sent forward returned with the welcome news that a fire was kindled about a quarter of a mile farther on the way. Mr. Banks then endea-

voured to wake Dr. Solander, and happily succeeded; but though he had not slept five minutes, he had almost lost the use of his limbs, and the muscles were so shrunk that his shoes fell from his feet. He consented to go forward with such assistance as could be given him; but no attempts to relieve poor Richmond were successful. It being found impossible to make him stir, he was left with two others to look after him, under the promise that they should be soon relieved. Mr. Banks with much difficulty at last got the doctor to the fire; and soon after sent two of the people who had been refreshed, in hopes that, with the assistance of those left behind, they would be able to bring Richmond, even though it should still be found impossible to wake him. In about half an hour, however, they had the mortification to see these two men return alone; they said that they had been all round the place to which they had been directed, but could neither find Richmond nor those who had been left with him; and that though they had shouted many times, no voice had replied. This was matter of equal surprise and concern, particularly to Mr. Banks, who, while he was wondering how it could happen, missed a bottle of

rum, the company's whole stock, which they now concluded to be in the knapsack of one of the absentees. It was conjectured that with this, Richmond had been roused by the two persons who had been left with him ; and that having perhaps drunk too freely of it themselves, they had all rambled in search of the fire, instead of waiting for help. Another fall of snow now came on, and continued incessantly for two hours, so that all hope of seeing them alive was given up ; but about twelve o'clock, to the great joy of those at the fire, a shouting was heard at some distance. Mr. Banks, with four more, immediately went out, and found one of the party with just strength enough left to stagger along and call out for assistance : Mr. Banks sent him immediately to the fire, and by his direction proceeded in search of the other two, whom he soon after found. Richmond was upon his legs, but not able to put one before the other ; his companion was lying upon the ground, as insensible as a stone. All hands were now called from the fire, and an attempt was made to carry the sufferers to it ; but this, notwithstanding the united efforts of the whole company, was found to be impossible. The night was extremely dark ;

the snow was now very deep, and they found it very difficult to make way through the bushes and the bog, all of them getting many falls in the attempt. The only alternative was to make a fire upon the spot; but the snow made this quite impossible: they were therefore reduced to the sad necessity of leaving the unhappy wretches to their fate; having first made them a bed of boughs, and spread a covering of the same kind over them to a considerable height. Having now been exposed to the cold and the snow near an hour and a half, some of the rest began to lose their sensibility, and one was taken so ill that it was thought he must die before he could be got to the fire. They passed the night in this frightful situation with no food, except the carcase of a vulture which had been shot the day before; at about eight o'clock a thaw commenced, and at ten they were able to set out for the ship, which they happily reached without any further calamity. The poor wretches whom they had been obliged to leave among the bushes were again visited, but they were quite dead.

If such are the dangers of extreme cold in the open country, and if even the crowded city is not exempt from like evils, we shall also find that the

formation of ice on rapid rivers, during the earlier part of the winter, is full of danger to those who have to cross them. The broad rivers of North America are especially dangerous when partially frozen, and charged with masses of floating ice. The river St. Lawrence opposite the town of Quebec is a mile and a half wide, and at the commencement of winter freezes three or four hundred yards from each bank, while the channel is filled with masses of ice, driven about by the eddies of an impetuous tide, and rising one above another in enormous lumps, or sailing along in flakes of three or four thousand yards in extent. Sometimes these masses meet and drive against each other with a tremendous crash, flakes are piled upon flakes, and fragments dashed about in frightful confusion.

The passage of the river under such circumstances was made by Sir George Head in a long canoe, which was nothing more than fourteen or fifteen feet of an entire tree, rounded at both ends alike, and hollowed by the adze. A piece of rope, six or eight feet long, was fixed to each end. Six Canadian boatmen were required to manage this canoe; each man carried an axe stuck in his sash, and a paddle in his hand: thus equipped they

dragged the canoe from the shore along upon the ice, chopping away the last six or eight feet, where it became unsound, with their axes, till the head of the vessel was brought close above the water. The time chosen for crossing was nearly at ebb tide, when the rapidity of the stream was of course much abated; still the ice was continually in a state of violent motion, and presented a very formidable appearance. Our traveller and his servant sat at the bottom of the canoe, in the centre, and waited for a launch, while the boatmen were chattering and arguing as to the best method of proceeding. A large flake floated by, leaving a clear channel of perhaps one hundred yards across; and this was the signal to begin. The travellers had nothing to do but to sit still. "*Tenez ferme!*" ("Hold fast") the boatmen all cried at once, and then pushed the canoe off the ice plump into the water with a splash. The fall was about two feet, and she was no sooner in than the men were on board, and each in his place paddling with eager haste, in order to avoid a large piece of ice which was bearing down, and so to gain a frozen surface right ahead. Succeeding in the attempt they nimbly jumped upon it, and seizing the rope fixed

at the head of the canoe, drew her by main force out of the water ;* and three at one side and three at the other, they pushed her along, running about a hundred and fifty yards across, till a second launch into clear water called again for the paddles. " We were less fortunate in this," says Sir G. Head, " than in the one preceding ; for we were splashed all over, and the water almost immediately froze hard on our clothes. But we had not time to shake ourselves, for a large quantity of loose ice, which appeared just to have risen up from the bottom of the river, was bearing down upon us in a very formidable manner. The men paddled and strained and chattered, but all would not do, and we were in a very few seconds hemmed in and jammed on both sides by a soft pulpy mass, together with which we were helplessly carried away by the current sidewise from the point we were endeavouring to reach. I could not help admiring the determination and address of the men at this moment ; for they jumped out above their knees in water, sometimes up to their hips, while they used their utmost strength to drag the canoe forward by the rope. Although the surface gave way contin-

* See Frontispiece.

ually under their feet, letting them down upon the large slabs of ice which were floating underneath, they managed by pulling and hauling, and with their axes occasionally cutting and breaking away the obstructing blocks which stood in their way, to get free of all impediments, and gain once more a channel of free water. While this was going forward, it was extremely annoying to be perfectly helpless in the midst of so much bustle and energy ; and when the fellows shouted, ‘ *Branlez, branlez !* ’ they meant that we should rock the canoe from side to side as we sat, to prevent her freezing on to the ice, which disaster was only to be avoided by keeping her in continual motion. If this had taken place, the consequences might have been serious, as the day was intensely cold, and we must have floated away with no very great chance of assistance It seems almost incredible that men should be able to work at all upon ice so unsound as not to afford a surface capable of supporting the weight of the body ; but on their part there seemed to be no appearance of absolute danger, owing to the vast thickness of the floating substance, a comparatively small part of which was, as they knew, that which appeared above the water, and there

was invariably a lower stratum upon which they were received and supported as often as they sank in." After more than an hour's exertion, they reached the opposite shore. The events of the passage are thus summed up:—"At one moment we were in clear water; the next moment struggling through congelated heaps of melted snow; then rapidly driven along over sheets of ice, and pushed over obstructing blocks which opposed our progress in ridges seven or eight feet high. The Canadians were, however, indefatigable. Every obstacle, as soon as encountered, was surmounted in a moment. Hard ice was hewn down with the hatchets. They were active as ants. All was energy, spring, and bustle. They were in the canoe and out of the canoe, paddling and cutting, pushing with the boat-hook, and hauling on the rope, all with instantaneous impulse and appliance of strength in different ways, and with the most effective success."

Ten days after the date of this passage, the ice set in the St. Lawrence. The masses of floating ice had attained a very great thickness, and continued to increase in size every hour, as they were carried about in the stream by the current—the rapidity of which had hitherto prevented their adhering;

but now, the increased cold and obstruction of the river caused them to stick together, at first, by twos and threes, and then jostling more and more at every side, till, at last, a general jam, for a moment, took place; and a moment was quite sufficient. The intense frost effected adhesion; and the water below splashing up between the interstices of the joints, effectually fixed and rivetted the whole. "As soon as the ice has stopped, the river presents to the eye a wild and noble spectacle. The moment is naturally one of conflict and convulsion; and the throes and struggles of the impinging bodies are truly tremendous. Small islands of ice, pressed on every side till they give way, break in the middle, and, cracking into fragments, these become hurled one upon another in all sorts of grotesque forms; so that, 'when the hurlyburly's done,' the whole surface of the river becomes covered, as it were, with little hills, houses, and villages. Objects that resemble all these are raised, as by the contrivance of magic, in the space of a few minutes. Some are of such considerable size that, through the whole winter, a circuitous track is taken to avoid them. And thus, although the inhabitants may immediately

avail themselves of a passage, it is, nevertheless, necessary to break a road. Like any other desert track, a way must be cleared of impediments; however, as blocks of ice are easily cut through, much time is not required to put everything to rights, and then crowds of persons flock to each side, eager to avail themselves of the first opportunity of crossing over." The formation of this road, which is called the "*pont*," or bridge, is hailed by the inhabitants of both sides with joy; by the country people, owing to the prospect of bringing their produce readily to market; and by those of the town, from the hopes of a reduction in the prices of the articles,—the natural consequence of the event. The track soon becomes as well beaten as any part of the streets; the large slabs of ice which had been removed, as well as heaps of snow, forming a wall on each side.

In many countries the course of frozen rivers affords the best and easiest road for travellers during winter; so that long journeys are frequently postponed until the frost has set in, for the sake of the advantage thus afforded. But, in the early part of the season, this kind of travelling is not without its dangers. Long after the surface of the

river has become frozen over, there are particular spots which, owing to the influence of currents or springs, are deceitfully unsound. And when the ice has acquired considerable thickness, the confined air will sometimes burst it asunder and produce chasms, or *air-holes*, as they are called, which, becoming again lightly frozen over, appear sound until the moment when they give way.

The writer already quoted, describes a journey performed in the early part of winter, in a sledge drawn by two horses, on the river St. John. "The driver rattled his horses on at a brisk gallop, till they, by degrees, settled down into their fastest trot. The sound of the runners upon the ice, and of the horses' feet, together with the perfect indifference with which the driver treated repeated loud cracks, which were distinctly audible, was to me altogether new. Still the motion was agreeable, and the labour of the horses so light, that there was very much to be pleased with. So, finding that he whose business it was to judge of the soundness of the ice was satisfied, I very soon left off thinking about it." After a time, however, the appearance of the ice became alarming. "Large serpentine tracks of water were to be seen in many

parts; and heaps of broken ice, forced up by the strength of the current, lay ranged on each side in considerable profusion. From some country people, whom we met, we were told that the passage was not safe; but that the road on the opposite bank was already sufficiently broken to render it tolerably good. The driver, therefore, bore away for the shore, which we were some time in reaching, being obliged to go out of our way frequently, to avoid the weak and unsafe places. At last, when within about a couple of hundred yards from the land, there seemed a clear sheet of ice, over which the driver urged his horses at a brisk trot, when, all at once, the ice suddenly gave way, and down went the horses head foremost into a hole. We were going so fast that I was flung out a long way clear of the water; and, as soon as I could get up, I ran back to render my assistance. One of the horses had already scrambled out, but the other was lying on his side in the water, with his head stretched out over the forward end of the hole, and supporting himself by his cheek and all the strength of his neck on the ice. The hole was nearly round, and the diameter rather more than the length of the horse; but, as the ice about it was

full a foot and a half thick, the sleigh had jammed at the other end, and his hind quarters were supported by the breeching. The poor creature lay without struggling, although the day was bitterly cold, and he had sunk so low, that his head only was above the surface of the water. In this dilemma the driver, having freed the other horse from his harness, slipped a noose of rope round the drowning animal's neck, upon which we pulled till he seemed nearly strangled; and this operation is called in the country, very properly, 'choking.' Whether it was that he floated by means of the air thus forcibly retained in his lungs, as the driver asserted, or whether our united efforts caused him to rise, I cannot say; but so he did; and we had not continued to tug long, before out he slipped on his side, and after a few kicks and struggles, stood frightened and shivering once more on his feet on the ice. We got to the shore, after all, with some difficulty; for the ice was broken away for so great a distance from the edge of the river where we attempted to land, that it was with very great labour that the horses could drag the vehicle over the hard snow and shingle which obstructed their progress. Although the poor horse had been nearly a quarter

of an hour in the water, and the other also was perfectly wet from the accident, both soon recovered themselves, and before we had gone a couple of miles, were quite as well as ever."

The power of many of the lower animals to endure cold is very remarkable. It is supposed that the mosquitoes which appear full grown in the earliest part of spring, are not the produce of that season, but have remained in a frozen state during the winter. This is known to be the case with many others of the insect tribe. Mr. Ellis mentions a black frozen mass of a turf-like substance, which, when thawed, produced a swarm of mosquitoes; and Hearne says, that spiders frozen so hard as to bound from the floor like a pea, were revived by being brought to the fire. Leeches, snails, grubs, and frogs, have been frozen by cold and revived. Hearne has noticed that frogs burrow under the moss at a considerable distance from the water, where they remain in a frozen state till the spring. He has frequently seen them dug up with the moss, frozen as hard as ice; in which state the legs are as easily broken off as a pipe stem. By warmth they regain their usual activity; but if permitted to freeze again, they are past all recovery. Hood

noticed that on the melting of the snow, the noise made by the frogs was almost incredible; nor is it possible, he remarks, that the multitude which incessantly filled our ears with its discordant notes, could have been matured in two or three days of spring. Capt. Franklin also mentions a curious fact with regard to fish:—"The fish froze as they were taken out of the nets, and in a short time became a solid mass of ice; and by a blow or two of the hatchet were easily split open, when the intestines might be removed in one lump. If in this completely frozen state they were thawed before the fire, they recovered their animation. This was particularly the case with the carp; and we had occasion to observe it repeatedly, as Dr. Richardson occupied himself in examining the structure of the different species of fish, and was always, in the winter, under the necessity of thawing them before he could cut them. We have seen a carp recover so far as to leap about with much vigour, after it had been frozen for thirty-six hours."

The utmost rigours of frost belong to arctic regions. Among the inaccessible mountains and deep ravines of Greenland, fields of eternal ice tes-

tify to the severity of the frost, and along the coast the cold is often -36° , and even -48° Fahrenheit. At such times rocks are split asunder by the intense frost: the pillow of the sleeper is encrusted with ice an inch thick, from his frozen breath; ice penetrates down the chimney almost to the stove, and forms an arch over its mouth, with little holes through which the smoke issues; the surface of the sea coagulates into a thick crust; beer and other strong drinks are frozen; brandy and spirits of wine become thick and clammy like oil. A vapour, like smoke, rises from the sea, and wafted into the cold atmosphere, freezes into fine particles, which, when driven against the face and hands by the wind, enter the skin like needles. Meat, frozen into stony masses, has to be thawed in snow water before it is cooked; and even when set over the fire and boiled for a long time, the outside only is fit to be eaten, the middle being too hard to be pierced with a knife.



WENHAM LAKE. THE ICE-COMPANY'S SERVANTS CUTTING ICE.

CHAPTER II.

THE FREEZING OF STILL WATER—EXPANSION OF WATER BEFORE
FREEZING—BEAUTY AND WISDOM OF THE ARRANGEMENT—THE
FREEZING OF RUNNING WATER—GROUND-ICE—EXAMPLES OF ITS
FORMATION IN DIFFERENT COUNTRIES—AMAZING FORCE OF WATER
IN FREEZING—ECONOMICAL USES OF ICE—ICE-MAKING IN INDIA—
AMERICAN TRADE IN ICE—THE WENHAM LAKE ICE COMPANY—
SKETCH OF THEIR PROCEEDINGS IN CUTTING, STORING, AND EX-
PORTING ICE—ICE-HOUSES—PORTABLE ICE-HOUSE—GREAT USE OF
ICE-HOUSES—CUTTING AND STORING OF ICE IN RUSSIA—ICE-CELLARS
—FROZEN MARKETS

To understand the manner in which water becomes ice, it is necessary to remember that the general effect of heat is to expand bodies, while that of cold is to contract them. Cold water occupies less space in a vessel than hot; for the heat, by separating the particles of the water, increases its bulk; hence, also, warm water is lighter than cold, and floats upon its surface.

Any one, on first becoming acquainted with the condensing power of cold, would naturally suppose

that the bulk of water would go on constantly diminishing by increased cold, until it became ice; but if such were the case, the ice of our lakes and rivers would not remain upon the surface, but would sink to the bottom, and every successive layer would also sink in the course of freezing, until the whole became frozen.

There is, however, a very remarkable and beautiful exception, in the case of water, to the general law above stated. As soon as the temperature of the water sinks a little below 40° , it ceases to contract by cold; and any further reduction of its temperature produces quite a contrary effect, causing it to expand, and consequently to become lighter, until it reaches the freezing point, namely, 32° . At this point, a further and sudden expansion takes place, and it becomes ice. If it were not for this beautiful provision, our ponds and lakes would at almost every frost become solid masses of ice, which the heat of the next summer would scarcely suffice to melt: the fish, and other tenants of the pool, would be destroyed; the temperature of our climate would be materially altered, and the consequences would be very serious..

To make this subject more clear, let us suppose

a freezing wind to be blowing over a lake. This will soon cool the water at the surface, and make it sink; and will continue to do so until the water at the surface has reached the temperature of about $39\frac{1}{2}^{\circ}$, its point of greatest condensation. After this, the continuance of the cold will indeed lower its temperature; but instead of making it contract as before, it actually causes it to expand, and by making it lighter, keeps it at the surface, and thus prevents the waters beneath from cooling down. The surface water continues to cool and to expand, until it reaches the temperature of 32° , when a sheet of ice is formed. This serves as a further protection to the water below from the cold wind. A long continuance of cold will thicken the surface ice, but be slow in penetrating to any considerable depth.

Such is the manner in which water freezes in lakes, ponds, and placid rivers. But in rapid and rugged streams, the case is often different. The eddies and irregularities of the stream, as it flows over a rocky channel, have the effect of mixing the layers of water together; so that the cooler surface, at one moment exposed to the freezing air, is at the next moment hurried to the bottom of

the stream. All parts of the water are therefore of about equal coldness. Such rivers do not often freeze on the surface, where the motion of the water is the strongest; but a spongy sort of ice frequently forms on stones and other projections at the sides and bottom of the stream, and sometimes extends over the whole bed of the river. This is the substance called by the Germans, *grundeis*, or *ground-ice*, respecting which there has been much difference of opinion among scientific men. Some persons continue to doubt whether ice can possibly be formed in this way; but the following instances are sufficient to prove it. The fishermen of the Elbe, when questioned on this subject, complained that during the cold days of autumn, long before any ice appeared on the surface of the river, the nets which were at the bottom of the stream often became encrusted with ice; also that the baskets used for catching eels, were often found covered with ice; that anchors which had been lost during the summer, floated on the surface during the winter, the ice acting like a cork to raise them up. This ice also raised the large stones to which the buoys were attached by chains, and occasioned much inconvenience by displacing these useful signals.

A few striking examples of the action of ground-ice are recorded by the Commander Steenk, of Pillau. In February, 1806, during a strong south-east wind, and a temperature a little above 34° Fahr., a long iron chain, to which the buoys of the fair-way are fastened, and which had been lost sight of in a depth of from fifteen to eighteen feet, suddenly made its appearance at the surface of the water, and swam there; it was completely encrusted with ice to the thickness of several feet. Stones also, of from three to six pounds weight, rose to the surface, surrounded with a thick coat of ice. A cable also, three and a half inches thick, and about thirty fathoms long, which had been lost during the preceding summer, in a depth of thirty feet, floated to the surface, enveloped in ice to the thickness of two feet. An anchor which had rested only an hour at the bottom, became so encrusted with ice, that it required not more than half the usual power to haul it up.

On the river Aar, a scientific observer noticed a quantity of floating ice appearing on the surface at a time when there was no sign of freezing either along the banks, or in shady places where the water was calm. It could not therefore be

said that the floating masses were formed at the banks; nor could they have floated down the stream, because, higher up, the river was remarkably free from ice. Flakes of ice were also seen to ascend and form ice islands in the centre of the stream; so that in all, there were twenty-three of these islands, the largest being upwards of two hundred feet in diameter. These were visited in a small boat, and the surface of each island was found to be a layer of compact ice, resting on a sort of inverted cone of spongy ice, which was fixed in the bed of the river.

The Rev. James Farquharson noticed the formation of ground-ice in the rivers Don and Leochal. He found that when it begins to form on the bottoms of the streams, it has a certain kind of orderly arrangement, reminding one of little hearts of cauliflowers shining with a silvery lustre; at first they are scattered irregularly, and in small number, but soon increase both in size and numbers, till the whole bed of the stream is covered. If the frost continues severe, they grow in height, but in a very irregular manner, till the streams are raised high above their former levels, so as frequently to overflow their banks.

The first appearance of the ground-ice is that of lumps of snow floating in water, which is called *gru* by the country people; the ice at the bottom of the stream just described, is therefore called *ground-gru*, and is justly dreaded in a district where streams are common, and many of them passable only by fords. Many horses refuse to enter any stream even slightly impeded by it, being greatly alarmed by the pieces which break and float up from the bottom by the action of their feet. This substance does not begin to form until the whole mass of the water is at, or about the freezing point, the air at the time being much colder. A clear state of the sky is most favourable to its formation. If the sky continues clouded during many hours, the ice becomes detached from the bottom, and floats down the stream.

The Rev. Mr. Eisdale has noticed the formation of ground-ice in the neighbourhood of Perth. According to him, it is well known in all northern climates, from its annoying effects in obstructing all works which are carried on by the impelling power of water; for the streams are sometimes gorged up from the very bottom. In the south of Scotland, this kind of ice is called *lapped-ice*;

the word "lapped" being commonly applied to the natural coagulation of milk. A miller, in the western part of Scotland, related to Mr. Eisdale a curious instance of the formation of ground-ice. During a severe frost, when the mill-lead was entirely free from any kind of ice, the miller had occasion one day to lop some branches from a tree, which overhung the lead; one of them fell into the water, and was left there, as he did not apprehend any ill consequences from so trifling an occurrence. Next day, however, to his astonishment, the water was turned entirely out of the lead, and had flooded an adjoining meadow. On proceeding to ascertain the cause, he found that a solid barrier of ice had been formed across the lead, where the branch had fallen in, so as completely to prevent any water from passing, while the rest of the lead was free from ice.

The beds of rivers often become greatly worn and deepened by the formation of ground-ice, and large portions of the soil are floated away, and deposited in places, where it would otherwise be difficult to explain their presence. Mr. Weitz has noticed this action in traversing some of the rapid rivers of Siberia, at the beginning of winter. These

rivers flow with great rapidity over a sandy, or stony bed; and although much snow falls, and the cold is severe, and of long duration, they continue to flow, bearing along vast quantities of floating ice. The great transparency of the water enables any one to see the ice at the depth of fourteen feet. It had a greenish tinge, and looked not unlike moss. When it separated from the bottom, and rose to the surface, it soon grew more compact by contact with the cold air, and floated away with the flakes detached from the sides. The pieces which rose from the bottom brought up sand and stones, which were thus transported by the current. On arriving at those parts of the river where, from the small slope of the bed, the motion of the water is slow, and the surface sometimes frozen over, the floating masses of ice collect and get fixed; thus forming a barrier to the ice-meers that come down, and contributing by this means to the congelation of the whole surface of the river. When a thaw sets in, the ice lets fall the gravel and stones, in places far distant from those whence they came.

We have already noticed that water, when just in the act of becoming ice, expands suddenly, and

with great force. Common examples of this expansion may be seen every winter in the bursting of bottles, ewers, &c., in which ice has been allowed to form. These, however, give a very faint idea of the force of freezing water. The barrel of a gun, or even the body of the strongest cannon, when filled with water to the muzzle, and tightly screwed up, has been known to burst under this process in a hard frost. In fact, no power in the world is strong enough to resist it. By this means rocks and mountains have been torn asunder, and their fragments scattered in the valleys beneath. Water, penetrating into their fissures or cracks, freezes in the early part of winter, and, in the act of freezing, bursts the solid rock asunder, with a noise that may be heard for miles.

In our own temperate climate, this force is exerted in the most beneficial way for the improvement of heavy soils. Stiff and clayey land, which absorbs moisture in winter, and hardens into a solid mass in summer, would be almost useless to the farmer if it were not for winter frosts. Such land is ploughed up in furrows, and thus exposed to the influence of the frost, which changes the moisture into ice, and, in doing so, bursts the

heavy clods, and causes them to crumble into fine particles as soon as the thaw comes to set them free.

Besides this important use of ice, there are a number of other uses for which it is valued, especially in hot climates. The oppressive heat of summer in Canada, and the United States of America, is in some way alleviated by the liberal use of ice. It is seen in every form, and used with the greatest profusion, being brought to table floating in water-jugs, or placed in a lump on butter, or handed round in small plates at dinner. In America ice is plentiful, and can, therefore, be indulged in freely; but in the East it is a great rarity, and is more economically used. Even in the burning climate of India, the inhabitants cool their drinks by means of ice; but, to procure this luxury, certain contrivances are required, which we proceed to notice.

The most extensive manufacture of ice is carried on in the neighbourhood of the town of Hoogly, about forty miles from Calcutta. The proper season is from the end of November to the middle of February. The ground where the ice is made, is formed into troughs, each about 120 feet in

length by twenty feet in width, and two feet in depth; the bottom is made smooth, and allowed to dry by exposure to the sun. It is covered with bundles of rice-straw, to the depth of about a foot, and then loose straw is strewed in, to a height within six inches of the adjoining land. The pans, containing the water to be frozen, are next arranged in regular order upon the loose straw. They are of unglazed porous earthenware, very much like those put under our garden flower-pots, and are arranged close to each other, in rows, to the number of five or six thousand. The natives fill the pans with soft pure water, by means of small earthen pots, fastened to the end of bamboo-rods, long enough to reach half-way across the trough. The water is taken from large water-jars, sunk deep in the ground, near the pits where the ice is stored, and filled from the neighbouring pools, or with drainings from the ice. The quantity of water poured into each pan, varies from a half to an eighth of a pint, depending upon the clearness of the sky, and the steadiness of the wind. The most favourable wind is from the NN.W.; but any point between north and west will do, although so large a quantity of ice may

not be expected. If the wind is at any point between east or south, no ice will be produced, and no preparations are made for it. The formation of the ice, which generally begins a little before midnight, is carefully watched by persons stationed near each trough. As soon as a slight film of ice is seen to form, the contents of several pans are mixed together, and the freezing liquid sprinkled over the others. The freezing continues till sunrise, when perhaps as much as half an inch of ice will be found in each pan. In very favourable nights, the water is entirely frozen. The ice is generally removed by women, seven or eight of whom are appointed to each ice-bed; they use a blunt semi-circular knife to scoop out the ice, which they throw, together with any unfrozen water, into earthen vessels placed near them. When these are full, their contents are poured into conical baskets, placed over the large water-jars, from which the pans are filled; by this means a supply of very cool water is collected for the next night's operations. The ice being sufficiently drained, is deposited in wells, near the ice-beds; and at night, removed to large circular pits, lined with mats, and covered over with a straw shed.

The heat of day, even in the ice-making season, is frequently greater than that of our hottest summer days, so that, after all precautions, a partial thawing goes on in the pits. The water thus produced, is carried off, through holes in the bottom of the pits, to a deep well, which also serves to supply the pans in the ice-bed: thus, throughout the process, it will be seen that the cold is economised as much as possible. The ice is conveyed in boats to Calcutta by night. When the weather is coldest, it is simply packed in bags; at other times it is packed in baskets, lined with straw-mats, and conveyed to the city before sunrise. During the hot season, when ice is most needed, it is scarcely possible to preserve it in any quantity; and the first heavy fall of rain usually melts all that is left of the last ice-making season. The demand for ice, and the high price which it fetches in India, have encouraged American merchants to supply the fragile luxury; and cargoes of solid ice are now actually shipped at Boston, in America, and discharged at Calcutta. This strange traffic was begun in 1833. The American ice was first sold at threepence per pound, and afterwards at a lower rate, while the native ice could not be sold

under sixpence per pound. The vessel which conveyed the ice was fitted up with an ice-chamber, the sides of which were formed of double planking, with a layer of well-dried tan, or bark, between. The ice was packed in large cubes, fitting closely together, so as to form one solid mass. The whole quantity shipped amounted to 180 tons, of which about sixty wasted on the voyage, and nearly twenty on the passage up the river to Calcutta, and in stowing away; so that about a hundred tons remained for sale.

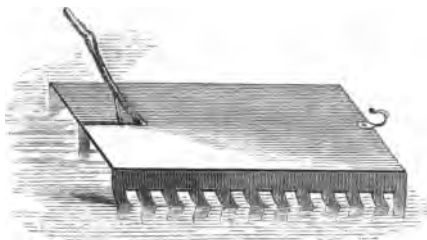
Finding the traffic likely to be profitable, the American merchants formed a company for the purpose of supplying ice to different nations of the world who were in want of this luxury. To insure an abundant supply of the crystal treasure, the company purchased a lake of pure water, situated in the state of Massachussets, about eighteen miles from Boston, to which port the ice is conveyed along a railway constructed for the purpose; and every year thousands of tons of ice are shipped to the East and West Indies, to South America, and to this country, extensive ice-houses being erected in London and Liverpool for storing the ice.

Wenham Lake, whence the ice is obtained, occupies an elevated position, and is surrounded by rugged hills. It is of great depth, and is supplied solely by springs which issue from its bed. Close upon the edge of the lake is the company's storehouse, built of wood, with double walls two feet apart, the space between being filled with sawdust; by which means the ice is protected from the external air, and can be preserved for any length of time. It is said that as much as twenty thousand tons of ice can be stored in this house.

The work of cutting and storing the ice is carried on throughout the winter. As soon as the ice begins to form, it is carefully swept and kept free from snow; and when the ice is a foot thick, the cutting is commenced. A surface of about two acres is selected, which at that thickness will furnish about two thousand tons. A straight line is then drawn across this area from side to side each way, and an ice-plough* being pushed along these lines, a groove is produced of about three inches in depth, and a quarter of an inch in width. The *ice-marker* is then used, which makes two new grooves parallel with the first, twenty-one

* See Frontispiece to this chapter, p. 38.

inches apart, one limb of the marker remaining in the groove first formed by the plough. The



ICE-MARKER.

grooves thus formed are then deepened by the plough to the depth of six inches. The marker is drawn by two horses, and the plough by one. The ice-saw is next introduced, and thus one entire range of blocks is got out: the second and the succeeding ranges are split off with a wedge-shaped spade, a slight blow being sufficient; and it is remarked, that as the weather becomes colder, the ice is more brittle. The blocks are removed upon low platforms, placed near the opening made in the ice, and furnished with iron slides, extending into the water. A man furnished with an ice

hook stands on each side of the slide, and catching the block, throws it up the slide with a sudden jerk upon the platform. These blocks, some of which weigh more than two hundred weight each, are then removed



ICE-SPADE.



ICE-HOOK.

to a sledge standing at the side of the platform, until about three tons are collected. This is then drawn to the storehouse, and landed on a fixed platform, and afterwards hoisted block by block into the house. Forty men, assisted by twelve horses, will cut and stow away four hundred tons of ice in a day.

None but the most compact and solid ice is fit for the market: a thaw, with a fall of rain or snow, succeeded by a frost, will cover the surface of the lake with opaque porous ice. An *ice-plane* is therefore dragged over the ice by a horse, which shaves it to the depth of about three inches or more, until clear ice is reached. The plane is made to run in

grooves, formed by the marker, and the operation is similar to that of cutting.

Some idea of the extent of the company's operations may be formed, when it is considered that every winter they have to collect sufficient ice to carry on their extensive foreign traffic, to fill their ice-stores at the lake, and the ice-houses which they have established in many of the large towns in America and elsewhere, and also to fill a number of private ice-houses during the winter. Although the company has to maintain a railway, and a considerable extent of shipping, together with a large establishment at the lake and the storehouses; yet the traffic is so extensive, and the trade so well managed, that even in England the ice can be furnished at any season of the year at a trifling cost.

This fact bids fair, in the course of time, to do away with our own trifling efforts in the way of ice-preserving. But, at present, the storing of ice for summer use is a regular employment in this country, whenever a severe frost affords a supply. It is collected from the surface of ponds and pools, and laid up in ice-houses built for the purpose, or in deep cellars where means are employed to keep it dry, and to shut out the external air. The latter

is the plan adopted by the London confectioners. Market gardeners sometimes preserve ice in heaps by merely building it upon an elevated base in the open garden, and covering it very thickly with straw and reeds. An ice-house, when properly made, will preserve ice for two years. The spot to be chosen for it, is in some high and airy situation, where the ground slopes sufficiently to carry off rain water, and where there are no trees or buildings to make it damp, or to keep off the air. There are many different ways of forming an ice-house, but the general plan has been to dig a deep pit, smaller at the bottom than at the top, and line it with brick or stone to a considerable thickness. A space is left at the bottom of the pit, one or two feet deep, to allow of drainings from the ice; and above this is laid a strong grating of wood, which forms the floor of the ice-house. Sometimes a cart wheel, with the convex side uppermost, is laid at the bottom of the ice-house; this makes a very good floor, hurdles and straw being placed upon it to allow of the drainings passing off. If the soil is at all damp, it is desirable to make a drain to a considerable distance, and in that drain to make an air-trap. A small low building, roofed with

slate or stone, covers the pit, the entrance to which is by a crooked passage with two or three doors.

A very useful miniature ice-house, which might be conveniently introduced into this country, is in common use among the Americans. This is the



PORTABLE ICE-HOUSE.

Refrigerator, or portable ice-house, consisting of a box with two lids, and sliding and perforated shelves, under which the ice is placed for cooling and preserving wines, fruits, and provisions, without permitting them to come in contact one

with another. The refrigerator is air-tight, and being constructed on the same principle as the large ice-houses, speedily reduces, by means of a few pounds of ice, every thing placed within it to an uniform temperature very little above the freezing point. In these miniature ice-houses, every American housekeeper through the warm season places provisions, and fruits of every kind; keeping for weeks, if desirable, large joints of meat. A block of ice, weighing a few pounds, is placed within it, and is a supply for several days, except when ice is broken off for table use, or for mixing with water.

Provisions are also kept on a larger scale by butchers, &c. in a public ice-house, for the use of which they pay a trifling sum per joint. Thus, under the burning climate of South Carolina, there is less loss in the way of butchers' meat, fish, game, &c. than in the comparatively temperate summer of our own metropolis. The meat being sent to an ice-house near the market every evening, is cooled down to near the freezing point, and comes out in the morning so cool that it retains its low temperature for a considerable time after being exposed upon the stalls. The

advantages of such a plan would be great among ourselves, and would save the enormous waste of meat which occurs here every summer, and which is said to amount to two thousand tons in London alone.

The storing of ice is carried on in Russia on a large scale, to meet the great demand for it in that country. The inhabitants are fond of cooling with it their wine, beer, and even tea, dropping a lump into each cup instead of sugar. During their short but hot summer, most of their provisions would spoil but for the ice-cellars, of which there are about ten thousand in St. Petersburg alone. Getting in the supplies of ice forms an important business in winter, and gives employment to thousands of persons. Their plans and their tools are less complete than those of the Wenham Lake company; but the result is similar. The loose snow is cleared away from the surface of the river Neva, and certain markings are made on the ice with the axe, as a guide to the after proceedings. The men then work with axes in making deep grooves or furrows, in which they are at last almost hidden while stooping at their toil. But they take care to go so deep only as to leave a surface

of sufficient strength to bear their weight. When the block is thus furrowed on all sides, they remove from it, and give the decisive separating blows from above. In order to get the block out of the water, an inclined plane is formed on the thick ice, a couple of holes are made in the floating mass, and, strong hooks being inserted, it is dragged out of the water by the united efforts of many men. Sometimes a wooden machine resembling a brewer's dray, is introduced under the mass, and hauled out by means of ropes. The larger blocks, when once detached, are easily broken up into smaller ones, being first marked out by rule and line, and then split asunder with the crow-bar. The blocks are then set up on end, like stones from a quarry; and may be purchased wholesale or retail. Long trains of sledges laden with these blocks are to be seen on their way to the city; each sledge driver seated on an icy throne, and singing as he goes. On delivering them at the destined places, they are thrown into cellars, where the slabs are piled up regularly like walls, and then made into convenient larders, by hewing shelves, ledges, niches, &c. in the ice, for the purpose of placing thereon, in summer, the meat, fish,

milk, &c. which is to be preserved. These are the best kind of ice-cellars; but in the common sort the ice is merely thrown in, broken to pieces with the axe, spread over the whole level of the floor, and then rammed down close. It soon freezes into one solid mass, on which the articles to be preserved are laid. An ice-cellar is reckoned by the Russians as a necessary of life, and they are at a loss to understand how housekeeping can be conducted without it. To find their stock of ice running short before the season is over, causes as great dismay among the Russian dames, as is felt in England on the discovery that the coal cellar is empty when the roads are blocked up with snow.

It may be easily supposed, that during a Russian winter no care is necessary in the preservation of food. It can be kept for almost any length of time; and, accordingly, the market at Petersburg is supplied with meat and game from very distant places. "The partridges," says Mr. Kohl, "come mostly from Saratoff, the swans from Finland; Livonia and Esthuria supply heath-cocks and grouse, and the wide steppes must furnish the trapp-geese, which flutter over their endless plains,

where the Cossack hunts them on horseback, and kills them with his formidable whip. All these birds, as soon as the life-blood has flown, are apparently converted into stone by the frost, and, packed in huge chests, are sent for sale to the capital." So rapid are the effects of frost in that country, that the snow-white hares which are brought in sledge-loads to the market, are usually frozen in the attitude of flight with their ears pointed, and their legs stretched out, just as they were at the moment of their death. Another curious sight at these markets is a frozen reindeer, its knees doubled under its body, its hairy snout stretched forth upon the ground, and its antlers rising majestically into the air; or perhaps a mighty elk, which disappears piece by piece, as the action of the saw and the axe separate it for distribution among the several customers.



Ice-Palace on the Neva.

CHAPTER III.

AMUSEMENTS ON THE ICE—SKATING—CURLING—ICE-BOATS—ICE-PALACE
ON THE NEVA—FROST FAIRS ON THE THAMES.

THE winters of England, when most severe, are generally the most agreeable to young and healthy persons, who are able to take plenty of exercise in the open air. Without any dread of being frost-bitten, they hasten forth as soon as the cold is established to enjoy their favourite amusements on the ice. Nor must we suppose that the winters of colder climates are without their beauty and enjoyment. The effect of wind in increasing the power of cold over the human frame, is well known

even in this country, and is felt distressingly in northern regions; but, in still, bright weather, the cold, though intense, is bearable and even pleasant. Thus an English lady writing from the frozen shores of the Baltic, where she passed a winter, says: "There is something very exhilarating in this breathless, still, bright, cold, with a clear white expanse, a spotless world before you, every tree fringed, every stream stopped—freedom to range over every summer impediment; while the crystal snow lighting up into a delicate pink or pearly hue, or glistening with the brightest prismatic colours, beneath the clear low sun, and assuming a beautiful lilac or blue, where our long shadows intercept its rays, can no longer be stigmatized as a dead, lifeless white."

Skating and sliding on the ice are among the pleasures peculiar to winter. Sliding is almost too fatiguing to be long enjoyed; but skating is indeed a real pleasure. Bounding forward with the lightness and swiftness of a bird, and apparently with as little fatigue, or sporting in graceful curves upon a small plot of smooth ice, the skater may continue to enjoy his harmless sport for hours. In Holland, where long canals connect towns and villages, as

common roads do in other countries; the ice is smooth and in excellent order, and it is not uncommon for the young Dutch women to skate to market with their baskets on their heads. Skating, as an amusement, is also much practised by this people, and by the northern nations generally,—

“Where the Rhine,
Branch'd out in many a long canal, extends,
From every province swarming, void of care,
Batavia rushes forth; and as they sweep,
On sounding skates, a thousand different ways,
In circling poise, swift as the winds, along,
The then gay land is maddened all to joy.”

In Norway, Lapland, Sweden, and other cold and rugged districts, the ice is buried beneath enormous loads of snow, which cannot be traversed without the snow-skates described in “The Snow-Storm.” In England, the winters are happily too short and too mild to admit of much skating, but still there is usually enough to give an agreeable variety to our out-door pastimes.

To become a good skater is not so easy as might be supposed. It is necessary to begin early in life, and to disregard a few falls, which the learner is sure to encounter. Most persons soon acquire the

art of moving with tolerable rapidity upon the *inside* edge of the skate; but this soon fatigues the ankle, and prevents speed and anything like graceful motion. It is absolutely necessary to good skating to use the outer edge of the skate; for which purpose, the skater must throw himself upon that edge, making the balance of his body tend towards that side, which will enable him to form a semicircle. It has been recommended to the learner, to place a bag of lead-shot in the pocket next to the foot employed in making the outside stroke, in order to produce an artificial poise of the body. At the commencement of this stroke, the knee is to be slightly bent, and gradually straightened as the stroke is completed. When the learner becomes expert in forming the semicircle with either foot, he is then to join his feet together, and proceed alternately with both, which will carry him forward with a graceful movement.

It is easy to tell at a glance whether a skater is using the inner or the outer edge of his skate. If the inner, it will be impossible for him to describe more than two curves, and these will be *inwards*; that is, the right foot will constantly turn towards the left, and the left towards the right;

but if the *outer* edge is used, the skater may command an almost endless variety of figures and modes of movement, some of which are well known to skaters by such odd names as the "Dutch travelling roll," the "spread eagle," the "Mercury figure," the "backward outer edge," the "circle," the "figure 8," the "figure 3," the "worm and screw," and many others.

In Scotland, a favourite game is played upon the ice, called *curling*. This greatly resembles the pleasant summer game of *bowls*, but it is played with blocks or cylinders of stone, instead of wooden bowls or balls. The upper and under surface of each stone is made flat and smooth, so as to slide easily upon the ice, which should also be quite smooth and level, and free from cracks. The course being chosen, a mark is made at each end called a *tee*, while the course itself is called a *rink*. The tee is a small hole made in the ice, round which are drawn two circles of different diameters, to enable the players at a glance to tell the distance of their stones from the tee. A line is then drawn across the course at each end, at a distance from the tee of about the sixth part of the length of the course; this is called the *hogscore*, and all stones

that do not pass this line are rejected as useless. The length of the course may vary from thirty to fifty yards, according to the state of the ice; the breadth is about ten or twelve feet. The game is played as follows: The players are divided into two parties, one from each playing in turn. The first player throws his stone along the ice, and endeavours to place it as near the tee as possible. The object of the second player is the same as that of the first, and to effect it, it is often necessary to strike away the stone of his antagonist, and leave his own near the tee; this requires nice play: or he may place his stone near the tee without regarding that of his antagonist; in which case, if it is not displaced by the succeeding players, it may gain a shot to his party. The object of the next player is to defend the stone of his partner, or to knock away that of his antagonist. When the stones on both sides have all been played, the one nearest the tee counts one; and if the second and third, &c. belong to the same side, these count as shots, of which thirty-one, and sometimes twenty-one, is the number which makes the game.

Two captains, called *skips*, are attached to each rink. The skip is an important personage in the

game, for he not only takes his turn at the tee, but instructs and advises the others of his party. He is provided with a besom for keeping the course clear.

The great curling county of Scotland is Dumfriesshire, where, every winter, matches, called *bonspiels*, are played between rival parishes or districts, with as many as forty players a side. The populous parish of Lochmaben, which abounds in lakes, has, or had a few years ago, about a hundred and fifty curlers, competent to play in parish matches. Regular curling societies are formed, consisting of president and vice-president, secretary and vice-skips, and members. The officers just named form the annual committee of management, and regulate the sport. We are happy to be able to state, that these societies, while they tend greatly to promote health, also cultivate a good and kindly feeling between different classes of society, by mingling them together in one common pursuit.

“ Now rival parishes and shrievedoms keep,
On upland lochs, the long-expected tryst,
To play their yearly bonspiel. Aged men,
Smit with the eagerness of youth, are there,
While love of conquest lights their beamless eyes,
New nerves their arms, and makes them young once more.

* * * * *
Keen, keener still, as life itself were staked,
Kindles the friendly strife : one points the line
To him who, poisoning, aims and aims again ;
Another runs and sweeps where nothing lies.
Success, alternately, from side to side,
Changes ; and quick the hours unnoted fly,
Till light begins to fail, and deep below,
The player, as he stoops to lift the coit,
Sees, half incredulous, the rising moon.
And now the final, the decisive spell,
Begins ; near and more near the sounding stones,
Some winding in, some bearing straight along,
Crowd jostling all around the mark ; while one,
Just slightly touching, victory depends
Upon the final aim : long swings the stone,
Then, with full force, careering furious on,
Rattling it strikes aside both friend and foe,
Maintains its course, and takes the victor's place."

Grahame.

By a contrivance similar to that of skates, boats are urged forward in Holland, and are very rapid in their progress. By these *ice-boats*, as they are called, goods and passengers are conveyed along the frozen rivers or across the lakes. The boats are of different sizes, and are placed crosswise upon a thick deal board, which is furnished, at each end, with fixed irons turned up in the form of skates. Upon this plank the boat rests while it glides smoothly over the ice : the two ends of the boat

serve as out-riggers to prevent oversetting; and ropes are fastened to them leading to the head of the mast, in the nature of shrouds, while others pass through a block across the bowsprit. The rudder is made somewhat like a hatchet, with the head placed downwards, which, being pressed down, cuts the ice, and serves all the purposes of a rudder in the water, by enabling the helmsman to steer. When the wind fills the sails of these boats, they go with incredible swiftness, so much so as to affect the breath of the passengers.

Among the amusements connected with ice may be mentioned the building of ice-houses, and carving the ice into various figures.

Towards the end of the year 1739, the Czarina Anne of Russia resolved to erect an ice-palace, or pleasure-house, on the Neva. The first attempts were not very successful, as the slabs of ice chosen for the walls were not sufficiently thick, and a thaw ensuing, the whole gave way. On the return of frost, large blocks of clear transparent ice were chosen, squared, and cut with as much care as if they had been stone, or a permanent building had to be erected. The blocks were raised with pullies and regularly laid on each other; their

joints were cemented with water, which, being poured into them, froze immediately and served the purpose of mortar. The house, when finished, was fifty-six feet in length, seventeen and a half broad, and twenty-one in height. It consisted only of one story. The front presented seven openings at equal distances ; the centre of which formed the door or portico, and the other six the windows, the frames and panes of which were all of ice. The portico was surmounted with a pediment, from each side of which proceeded a balustrade surrounding the top of the building, having a statue at each corner, and two others at the top of the entry, all carved in the same material. Another balustrade surrounded the palace, having pillars supporting large balls. This inclosure had three entries, one facing the portico, and one at each side. At the side entries were pillars supporting urns, with orange trees ; the branches, leaves, and flowers of which were all of ice. A little further off, on each side of the house, was a square pyramid made hollow, for the purpose of containing a light by night. On the right side, beyond the pyramid, was an elephant of the size of life, with an armed Persian riding on his back, and

two attendants walking. By day, the figure threw water from its trunk, and by night ignited naphtha. A man enclosed within the figure, imitated the cry of the elephant.

On the other side of the house was a tent containing a hot bath, in which persons actually bathed. There were also six cannons of ice loaded with gunpowder and balls of ice and iron, which were discharged; and also two mortars, which threw out bombs of eighty pounds weight. The cannons were mounted upon carriages; and one of the cannons being charged with a quarter of a pound of powder, drove a bullet through a board two inches thick, at the distance of sixty paces.

The interior of this strange building consisted of a lobby and two large apartments, which were painted and well furnished, though merely formed of ice. Statues, tables, chairs, looking-glasses, candlesticks, a pendulum clock, a variety of ornaments, besides a cupboard containing a complete tea-service, and plates of provisions, were all seen in one apartment, and all formed of ice, and painted to represent the real objects. The other chamber was a bed-room, containing a state-bed with its curtains; a toilette, on which was placed a large

mirror; bed, pillows and bed clothes, two pairs of slippers, and two night-caps,—all formed of ice. Candles of ice were made to burn by means of naphtha; and in the fire-place a fire of ice was burning, that is, blocks of ice were smeared with naphtha and then kindled.

By day, the interior was illuminated by a blueish kind of light, very soft and beautiful; but, by night, when lit up with candles, the transparent walls showed the whole of the interior to the admiring spectators. Crowds of visitors were continually seen around this singular edifice, which remained entire from the beginning of January till towards the middle of March, when it began to thaw; it was then broken into pieces, and removed to the imperial ice cellar.

The wonders of this ice-palace were told to foreign nations, and it was, at the time, an object of universal interest. Cowper notices this “most magnificent and mighty freak, the wonder of the North,” and thus addresses the “imperial mistress of the fur-clad Russ”—

“No forest fell,

When thou wouldst build; no quarry sent its stores
To enrich thy walls: but thou didst hew the floods,
And make thy marble of the glassy wave.

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In such a palace Poetry might place
The armory of Winter ; where his troops,
The gloomy clouds, find weapons, arrowy sleet,
Skin-piercing volley, blossom-bruising hail,
And snow, that often blinds the traveller's course,
And wraps him in an unexpected tomb.
Silently as a dream the fabric rose ;
No sound of hammer or of saw was there :
Ice upon ice, the well-adjusted parts
Were soon conjoined, nor other cement ask'd
Than water interfused to make them one.
Lamps gracefully disposed, and of all hues,
Illumined every side : a watery light
Gleam'd through the clear transparency, that seem'd
Another moon new risen, or meteor fallen
From heaven to earth, of lambent flame serene.
So stood the brittle prodigy ; though smooth
And slippery the materials, yet frost-bound
Firm as a rock. Nor wanted aught within,
That royal residence might well befit,
For grandeur or for use. Long wavy wreaths
Of flowers, that fear'd no enemy but warmth,
Blush'd in the panels. Mirror needed none
Where all was vitreous ; but, in order due,
Convivial table and commodious seat
(What seem'd at least commodious seat) were there ;
Sofa, and couch, and high-built throne august.
The same lubricity was found in all,
And all was moist to the warm touch ; a scene
Of evanescent glory, once a stream,
And soon to slide into a stream again."

Compared with the splendours and festivities carried on upon the Neva, while this ice-palace was in existence, all the gaieties of the frost fairs on the Thames are very insignificant. Yet it was a merry time when princes, and nobles, and fair ladies thronged to our frozen stream, and patronized the printing presses and other devices there set up to celebrate the event. The surface of the Thames at London, has been frozen several times within the last eight hundred years; and on each occasion booths have been erected, games of various sorts carried on, and all the usual bustle of a fair enacted.

One of the most celebrated frost fairs was in 1683-4. The frost lasted two months, and the river was frozen to that degree that another city seemed to be created thereon. Evelyn, who was an eye-witness of the scene, thus describes it in his diary:—"The frost continuing more and more severe, the Thames before London was still planted with boothes, in formal streetes, all sortes of trades and shopes furnished, and full of commodities, even to a printing-presse, where the people and ladyes tooke a fancy to have their names printed, and the day and yeare set down

when printed on the Thames: this humour tooke universally, that 'twas estimated the printer gained 5*l.* a day, for printing a line onely, at sixpence a name, besides what he got by ballads, &c. Coaches plied from Westminster to the Temple, and from several other staires to and fro, as in the streets; sleds, sliding with skertes, a bull-baiting, horse-and-coach races, puppet-plays and interludes, cookes, tipling, and other places, so that it seem'd to be a bacchanalian triumph, or carnival on the water." This fair was visited by the king, (Charles II.) the queen, and the royal family; and a paper is still in existence containing their names printed on the Thames, according to the "humour" which Evelyn speaks of. The last frost fair on the Thames took place at the commencement of 1814, when all the usual proceedings were repeated; but their continuance was very short, commencing on the 30th of January, and being put an end to by a rapid thaw on the 5th of February.



GLACIER OF ZERMATT.—*Middle portion.*

CHAPTER IV.

THE GLACIER—ITS NATURE AND FORMATION—GLACIER STREAM—
DIFFICULTY OF ASCENDING A GLACIER—THE WRITER'S ASCENT
OF THE MER DE GLACE—THE MORAINE—LATERAL AND MEDIAL
MORAINES—WIDE CHASMS, OR CREVASSES—METHOD OF PASSING
THEM—ICE RILLS—LE MOULIN—MR. FORBES'S EXPERIMENTS ON
THE MOTION OF THE GLACIER—GLACIER-TABLES—GLACIER-
CONES—LE JARDIN—DESCENT OF THE GLACIER—BLOCKS OF STONE
IN THE VALLEY OF CHAMOUNY—THE TOAD-STONE—POLISHED
ROCKS.

TURNING from the puny works of man (for such must his most magnificent proceedings appear when compared with the works of God), let us now consider some of those awful and sublime scenes which are presented to the traveller in Alpine districts. Nothing can exceed the grandeur of those enormous fields of ice called glaciers, of which it is, indeed, impossible to give any description which shall truly represent their nature and appearance to one who has never visited them. Perhaps the best notion of a glacier might be gained by supposing some mighty river, a mile broad, and several hundred feet deep, pouring with vast waves down the rocky side of a mountain, but

suddenly checked in its course, and converted into ice, the gigantic waves split asunder, and projecting in sharp angles from the surface, while the whole should sparkle with dazzling brilliancy. Something of this sort filled the imagination of the poet Coleridge, when he thus addressed the glaciers of Mont Blanc—

“Ye ice-falls ! ye, that from the mountain’s brow
Adown enormous ravines slope amain—
Torrents, methinks, that heard a mighty voice,
And stopped at once amidst their maddest plunge !
Motionless torrents ! silent cataracts !
Who made you glorious as the gates of Heaven
Beneath the keen full moon ? Who bade the sun
Clothe you with rainbows ? Who with living flowers
Of loveliest blue, spread garlands at your feet ?—
God ! let the torrents, like a shout of nations,
Answer ; and let the ice-plains echo, God !
God ! sing ye meadow-streams with gladsome voice !
Ye pine-groves with your soft and soul-like sounds !
And they too have a voice, yon piles of snow,
And in their perilous fall shall thunder, God !”

But let us further consider the nature of these icy torrents.

Every one is aware that the atmosphere becomes colder as we ascend above the level of the sea, until at a certain height, varying according to the

climate, snow exists all the year round. At the equator, a height of 16,000 feet is required to preserve snow unmelted at all seasons; in the Alps of Switzerland and Savoy, a height of 8,700 feet is required; but in high latitudes, snow is found to exist all the year round at the level of the ocean.

The vast quantity of snow which falls every winter upon the lower regions of the earth is melted by the heat of the succeeding summer; but that which falls upon high mountains, and is beyond the melting power of the solar rays, accumulates to such an extent, that it slides off the mountain slope by its own weight, or by the action of winds and tempests, and forms "the avalanche—the thunderbolt of snow." The snow of these upper regions is also brought down by the warmth of spring acting just below the snow line. The water formed by the melting of the snow filters through to a great depth, where it is frozen. This process goes on year after year; the snow which falls above the snow line, is not melted until it is shot down to a lower level, where in melting, and again freezing, it forms the ice of the glacier. Now comes the most wonderful part of the history. These vast fields of ice, the result of thousands of

avalanches, do not remain fixed in the spot where they are first formed. Occupying, as they mostly do, the upper valleys and slopes of lofty mountains, they make a gradual, never-ceasing progress, not visible to the eye, yet always going on. The mighty glacier descends with slow but resistless motion into the lower valleys—a river of ice always wasting, and always being renewed; no human power can impede or direct its progress; onward it comes, numbering perhaps not more than three hundred paces in a year—until it overturns the huts of the peasantry, and exterminates, beneath its pondrous icy foot, orchards and fields of smiling corn.

But has the summer's sun no effect upon this gelid stream? Many glaciers at their termination in the lower valleys are a thousand feet high, and a mile across; so that it may well be supposed the longest summer, and the brightest sun of Switzerland, would make but a faint impression upon ice stored in a magazine of such dimensions, and extending often to a length of twenty miles. But the ice is being constantly wasted from a variety of causes. On approaching the foot of the glacier an icy cavern is seen, from which issues a rapid and



THE GLACIER STREAM. TERMINATION OF THE GLACIER OF ZERMAI.

Whitney

intensely cold stream of turbid water; this is derived chiefly from the melted snow and ice, which penetrates through the cracks and fissures of the glacier into a channel below, and wears for itself a cavern, whence it rolls into the light of day. Some of these glacier streams are of great force and intensity, varying, of course, with the season of the year, and the hour of the day; they have their greatest flood in July, when the sun has most power; and they swell visibly, and roar more loudly, as the hottest part of the day advances; they diminish towards evening, and are smallest in the night.

In standing before this crystal wall, and watching the torrent pouring from its bed, it seems as permanent a feature in the stupendous landscape, as the most solid rock or mountain; and yet there is scarcely any thing in nature more fleeting. The wall of ice which we gaze upon to-day cannot be said to be the same surface that we admired yesterday; the form is the same, but the substance is perhaps hundreds of miles away, hurrying towards the ocean on the bosom of the Rhine, or forming part of the dark blue waters of the Rhone, for these rivers are supplied from glacier streams.

The daily waste of ice is daily renewed; it is pressed onward with resistless force; advances to a certain point, where it appears to remain stationary, until we look around and contemplate the scene of wild confusion and desolation which the glacier has wrought out: blocks of stone, varying from the size of a house to that of a pebble, are scattered around to a distance of many yards, and often miles, obliterating the traces of man's industry, and converting his orchards and corn fields into a stony waste.

The difficulty of ascending a glacier is well repaid by the grandeur and interest of the scene. Many tourists, in common with the writer, have experienced the highest delight in the ascent of the Mer de Glace, one of the five principal glaciers of Mont Blanc. In approaching this glacier, we travel on mules from Chamouny, and pass through a magnificent forest of pines and larches, situated on the steep slope of the Montanvert. The road winds up this in a series of zigzags; a great height is soon attained, and a glorious view is often seen as in a picture, with the noble forest trees for a framing. The road is bad, and the turns are frequent, but there is really no danger if the sure-footed mule is

allowed to take its own course. The road is, in fact, ploughed up and nearly destroyed by the descending avalanches of winter, and only a few loose stones, thrown hastily down, show that there is a road. The trees also bear fearful evidence of the power of falling masses of snow. Many of the monarchs of the forest lie prostrate; others have been snapped asunder, as if they were reeds, their blackened stumps remaining to tell of the conflict.

On reaching the summit of the Montanvert, the traveller first begins truly to appreciate the wild grandeur of the glacier—here called the *Mer de Glace*, although properly a *river*, not a *sea* of ice. From a height of about 240 feet, we look down upon the icy stream, and see it, for about two leagues, following the windings of the valley, pent in between walls of rock, surmounted by a thousand pinnacles, which often rise beyond the clouds, the loftiest of which, the *Aiguille Verte*, is more than 13,000 feet above the level of the sea, and about 7,000 feet above the grassy platform from which we now behold it.

Wishing to see more of this magnificent glacier, we set out with our guides to pay a visit to *le*

Jardin, a place situated in the centre of a snowy basin, above the snow line, where, from its peculiar situation, some scanty herbage and a few Alpine flowers grow during the short-lived summer. The distance from Montanvert, in a direct line, is about nine miles; but the surface to be crossed is so broken up, and requires so zigzag a course, as to render the distance much greater.

On leaving Montanvert we proceeded along a foot-path in the west bank of the Mer de Glace, which is here extremely steep, and consists of a slaty gneiss. It is covered with grass and the Alpine rhododendron; and here and there the spruce fir is seen. Large blocks of granite are scattered about wherever a ledge is found sufficient to maintain them, and they extend quite up to the dwelling of Montanvert. The face of the rock soon becomes smooth, and continues so down to the ice, the motion of which serves to wear away and polish the rock. The passage is here somewhat difficult, but is effected by means of rude steps cut in the slaty rock. There are two passes of this description, called the *premier et second ponts*, or the "first and second bridges." Here the glacier is greatly heaved and contorted; the icy

hillocks, or waves, are of enormous size, and rise to a great height.

The second pont being passed, the path descends to the *moraine*, as the immense collection of stones is called which fringe the edge of the glacier. These stones are torn from the rocks on both sides by the expansive force of ice. The rain and melting snow which fills the crevices with water, is frozen during winter, and in freezing, the icy wedges expand and rend off masses of stone often measuring fifty feet along one of their sides. The first thaw melts the ice which binds the blocks to the parent rock, and they come rolling down upon the glacier throughout the whole of the summer. This constitutes one of the chief dangers of glacier travelling. As the glacier creeps on, some of these stones also move with it until they are brought to the extremity of the glacier, when they are shot over its edge, and form what is called the *terminal moraine*. Other stones are thrown up on the banks or shores of the glacier. If these be very steep, the blocks fall into holes and openings left between the ice and the rock, where they are ground and chafed, and serve to polish the rock itself, producing grooves and scratches in the direction of the

moving ice. When the shore has a more gradual slope, the blocks are frequently stranded, and the heat of the ground usually causes the ice to sink at the sides, forming a sort of trough or hollow, in which the blocks accumulate in a ridge. It was along this ridge that we had to pick our way for a considerable distance: the climbing up and down among these stony masses was difficult and even dangerous, for some of them were so delicately poised, that a step was often sufficient to set them in motion and produce a fall. It is quite impossible to form a pathway over this *lateral moraine*, as it is called, because the glacier changes its dimensions in different seasons and in different years. When the glacier, like a swollen torrent, occupies its bed to an unusual depth, the moraine is uplifted with it; and when the warmth of summer reduces the bulk of the ice, the blocks are often left on rocky shelves at a considerable height above.

When two glaciers from separate sources unite in a common valley, exactly as two rivers would do, the edging moraines common to each unite upon the surface, and mark, by a band of stones, often for miles, the actual separation of the two ice streams. This new moraine of course occupies the centre of



the compound stream, and is therefore called the *medial moraine*. The accompanying diagram will illustrate the formation of the medial moraines, the arrows pointing in the direction in which the glacier-streams move.

Proceeding for some distance along the lateral moraine already noticed, we arrived at the foot of a perpendicular cliff much worn by the action of the ice, the furrows being marked in distinct parallel lines. In places where glaciers have long ceased to exist, these marks are often visible, by which means the icy stream can be traced to places where its presence might not otherwise have been suspected.

We had not yet left the moraine, when a loud but dull sound, something like that of a musket, was heard, which brought down a shower of blocks, and shook and disturbed the rough road, which we were about to quit. The noise was produced by the opening of a crack, or *crevasse* as it is called, in the ice. We now stepped upon the bare ice, which

at this part of the glacier was much smoother than at the lower part, and afforded excellent walking compared with the toilsome path we had just left.



POLISHED ROCKS.

The sun was shining brightly, and had thawed the surface sufficiently to give a certain degree of roughness; we therefore proceeded at a rapid pace over the ice, until we were suddenly stopped by a yawning gulf, or *crevasse*, about eight or ten feet

wide, and extending some sixty feet across the glacier. On turning the edge of this, and proceeding a little higher up, we came to another, which in like manner we avoided; but soon the crevasses became so numerous as to bewilder and confuse the stranger. The guides frequently paused to consult. Sometimes with the assistance of a long pole spiked with iron,* without which it would be quite impossible to travel among glaciers, we leaped across a crevasse; but this required caution, on account of the wide gaping mouths on the other side. Sometimes, to prevent a tiresome walk along the edge of a crevasse, the guides would form a kind of bridge with their batons, over which to help the traveller. The depth of these crevasses varies according to the thickness of the ice and their position in the glacier; on looking into them, the ice appears of a beautiful blue colour; but the eye cannot penetrate far. The crevasses are of course most dangerous when covered with a thin coating of snow: many travellers and hunters have thus been hurled into the abyss, and have miserably perished.

On continuing to ascend the glacier, the advanc-

* This pole is called a *baton* in French Switzerland, and an *Alpenstock* in German Switzerland.

ing heat of the day had its effect upon the ice, in thawing the water of a number of pools which were frequently met with. They are called *baignoirs*, and are formed from small holes or cavities in the ice. The warmth of the day also set in motion innumerable rills of water, which run along the hollows or furrows of the ice, and uniting in larger streams, pour down in bold cascades into the crevasses. On continuing to advance, a loud throbbing sound like the clack of a mill was heard, which the guides called *le moulin*. On advancing towards it, an abundant cascade, formed by the union of thousands of little rills, was pouring its waters into a cylindrical hole, on looking into which the stream was seen divided into two, each branch descending through a separate hole into the icy bowels of the glacier. As the holes were of considerable size, the disturbance of the air probably caused the clacking sound. A beautiful blue light, gradually fading into blackness, permitted a portion of the interior to be seen. It is remarkable that whatever be the state or progress of the glacier, these moulins are found in almost exactly the same position; that is, opposite to the same fixed objects on the side of the glacier,

The water on the surface of the ice, unlike the turbid stream which issues from the foot of the glacier, is of exquisite purity. The guides filled a glass with it, and it was welcome and refreshing; the rill sparkling at our feet was of icy coldness, while the hot summer's sun, which made it sparkle, was overwhelming us with heat.

It was here that Mr. Forbes, in the summer of 1842, performed his beautiful experiments to determine the motion of the glacier. Many of the marks made by him on the rocks and stones still remain, and were examined with the greatest interest. Previous to his inquiry, very contradictory opinions had been held on the subject; one writer assigned 180 yards per annum as the motion of the Mer de Glace; another two hundred yards, another a foot a day, and another only forty feet per annum. It was therefore quite clear that the rate of motion was not known at all. The surface waste of the glacier was also to be determined; and the questions whether the icy stream moved by night as well as by day; in winter as well as summer, and also whether the flow was quickest at the centre or at the sides, were likewise to be settled.

To find the motion of the glacier, Mr. Forbes made his observations opposite a solid wall of rock in contact with the ice, upon which might be marked the progress of the glacier as it slid by. A hole in the ice was made to the depth of two feet, over which the theodolite was nicely centered by means of a plumb line, and levelled. A level run directly to the smooth face of rock, gave the means for determining the sinking or rising of the glacier; for if this varied, the telescope would be no longer level, and the amount of variation being known, the alteration in the surface of the glacier could be easily determined. Other fixed marks were made for noting the downward or forward motion of the icy stream, which was afterwards measured from day to day on the smooth face of rock already noticed. These measurements were first made with a common pencil, and afterwards indented in the rock with a chisel, above which a mark was painted red with oil paint and the date affixed.

The various arrangements having been completed on the 26th June, Mr. Forbes made his first observation on the following day. On the telescope being turned upon the rock, it was found that the red

mark was left far above, the new position of the glacier being sixteen and a half inches lower down (that is, more in advance) than it had been twenty-six hours previously. Thus the daily motion of a glacier was determined for the first time by actual observation, and the methods employed left not a doubt of its being most accurately determined. But a question arose. Did the glacier flow down evenly, or was this motion the result of sudden jerks, or a partial dislocation of the ice from which the observation was made? These points could only be determined by repeated observations: accordingly, on the 28th June, Mr. Forbes hastened with not less interest to his station, and found that in twenty-five and a half hours the advance had been nearly seventeen and a half inches, or somewhat more rapid than on the first day. To prove that the motion went on by night as well as by day, the next observation was divided into two parts. At six o'clock on the evening of the 28th, the position of the glacier was ascertained: on the following morning, at six o'clock, it was found to have moved eight inches, or half the mean distance already observed; the night had been cold, the ice was still frozen, although the temperature of the

air had already risen to 40° . During the day the glacier advanced nine and a half inches, thus giving a total motion of seventeen and a half inches for the twenty-four hours, the rate appearing to increase as the warm weather continued. During the same afternoon, the distance which the glacier moved in an hour and a half was determined so that its continuous motion was now placed beyond a doubt. "The marks on the rock," says Mr. Forbes, "indicated a regular descent, in which time was marked out as by a shadow on a dial; and the unequivocal evidence which I had now for the first time obtained, that even whilst walking on a glacier, we are day by day, and hour by hour, imperceptibly carried on by the resistless flow of this icy stream, with a solemn slowness which eludes our unaided senses, filled me with an admiration amounting almost to awe, whilst I foresaw with lively interest the definite and satisfactory knowledge of laws which would result from these methods of observation."

On the 30th June, two observations were taken; during the night the glacier had advanced eight and a half inches, and by day nearly nine inches.

The uniformity of these results are the more

interesting, because the spot where they were obtained was a part of the ice surrounded by chasms, and greatly shattered in all its breadth. Yet, amidst all this turmoil and confusion, the glacier moves steadily on. By continuing the observations, it was found that, from the end of June to the end of September, the motion of the ice amounted to 103 feet. A very intelligent guide, employed by Mr. Forbes, watched the motion of the ice during the winter. From the 20th October to 12th December, 1842, the ice had moved seventy feet, thus giving a daily velocity of nearly sixteen inches, but little less than the average summer motion. From December 12th to February 17th, between which the coldest weather occurred, the daily motion was only thirteen and a half inches; and from this time up to the 4th April, 1843, the average daily motion again increased to rather more than seventeen inches; thus clearly proving that the glacier moves in winter as well as in summer.

To determine whether the icy stream moved quicker at the sides than in the centre, as was generally supposed, Mr. Forbes made two holes in the ice, one near the side, and the other near the

centre of the glacier. By means of fixed marks on the rocks, he determined the velocity of the different points as they flowed past. From the 29th June to the 1st July, the motion in twenty-four hours was seventeen and a half inches at the side, and upwards of twenty-seven inches in the centre; hence, contrary to received opinions, the glacier-stream, like a river, moves fastest towards its centre, where it is least exposed to friction. Other experiments proved that the velocity of the central parts is every where about the same, and that the greatest differences in velocity were close to the side, where friction may be expected to act exactly as in a current of water.

The change of level, or depression of the surface of the glacier, during the summer months, was far greater than had ever been suspected. In June, the surface sank at the rate of more than four inches a day; but this quantity diminished gradually, until, in September, it was only two and a half inches daily. This waste arises from the action of the sun and rain, setting free the innumerable rills and cascades already noticed, and washing and thawing the surface; but there are also other causes to explain the great daily waste

of this huge magazine of ice. The streams which pour down the various crevices, form a tolerably broad and rapid current below the glacier, whose motion wears away the ice, and forms spacious cavities; the ice in contact with the ground is also constantly melting, from the natural heat of the earth; the lower portion of the glacier also moves quicker than the upper part;—all these causes assist to change the level, or depress the surface of the glacier. During wet mild weather, the glacier has been known to sink as much as a foot a day.

But we must now continue our journey to the Jardin. After walking a few miles over the glacier, the valley, along which we had hitherto proceeded, expanded into an extensive plain, the centre of three valleys, each of which poured its icy stream into this common receptacle. The crevices are here of enormous size, and of great depth; the guides have sounded a moulin above 350 feet deep. Basins are also hollowed out in the ice, containing water of an exquisite blue colour. Here the origin of the medial moraine can be well traced. At the meeting of the icy streams, the masses of rock, previously forming the lateral

moraines, now move along in the centre.* One of these is an enormous block of granite, having one of its sides hollow, and forming a well-known refuge for the chamois-hunters, and the few travelers who intend to pass a night on the glacier. Mr. Forbes passed some nights here, and found it by no means disagreeable in fine weather. The glacier is in great measure concealed by its lofty embankments, which shelter it from the chilling winds; the slopes around are grassy, and dotted here and there with juniper bushes.

If some of these blocks of stone excite admiration by their size, others command attention by their singular position. Imagine an enormous block, or slab, of stone perched upon a stem of ice, like a huge mushroom; sometimes entirely supported, at other times tottering, and threatening to fall upon the spectator: sometimes the huge mass has slipped off, and rests against the side of its pillar. On the glacier of Léchaud, Mr. Forbes noticed a magnificent specimen of these *glacier tables*, or *chapeaux*, as they are called. It consisted of a flat block of granite, measuring twenty-three feet by seventeen feet, and about three and a half feet in

* See the diagram at page 92.



GLACIER TABLES.

thickness. In June, 1842, it was easy to step upon this stone, and Mr. Forbes erected his theodolite upon it, and from its summit made his observations on the movement of the ice at this part of the glacier. But as the season advanced, it changed its appearance remarkably. The waste of ice at the surface caused the glacier to sink all round the stone, while the ice immediately beneath it was protected from the sun and rain, as by an umbrella. The stone thus appeared to rise above the level of the glacier, supported on an elegant pedestal of beautifully veined ice. "Each time I visited it," says Mr. Forbes, "it was more difficult of ascent; and at last, on the 6th August, the pillar of ice was thirteen feet high, and the broad stone so delicately poised on the summit of it (which measured but a few feet in any direction), that it was almost impossible to guess on what it would ultimately fall, although, by the process of the thaw, its fall in the course of the summer was certain." On a still later day, when Mr. Forbes made a sketch of it, "it was," he says, "probably the most beautiful object of the kind to be seen any where in Switzerland. The ice of the pedestal presented the beautiful lamellar structure parallel

to the length of the glacier. During my absence in the end of August, it slipped from its support; and in the month of September it was beginning to rise upon a new one, whilst the unmelted base of the first was still very visible upon the glacier."

Glacier tables are formed only of such thick blocks of stone, as will prevent the heat of the sun from penetrating through: if the slabs are thin, and of a dark colour, a contrary effect is produced; instead of rising, they *sink*. The solar heat is absorbed so quickly, that it melts the ice beneath, and the stone soon disappears; a leaf wafted by the wind upon the glacier, a dead insect, or a few particles of black sand, will all sink, while blocks as large as a house, and weighing millions of pounds, are thrust up into the air.

Curious cones of sand, called *glacier cones*, are sometimes met with. They have been seen of so large a size as twenty or thirty feet in height, and eighty or a hundred in circumference. They are formed from the sand of the moraines, which, being washed by the surface-water rills into the deep cavities of the glacier, at length accumulates and chokes up the hole, and, as the ice subsides, a pyramid or cone of sand is left standing.

At the broad part of the glacier at which we have now arrived, we quitted the ice, and began to ascend the steep rock at the foot of the *Aiguille du Moine*. After much painful climbing, we arrived at a grassy platform, just large enough to accommodate our party of four; and as we were exhausted by the heat, and by this rude essay at mountaineering, we sat down to dine. Our tablecloth was spread near the edge of a precipice a thousand feet deep; behind us rose the Moine, several thousand feet, and before us were the glaciers, and wide fields of snow, and, towering above all, the majestic Mont Blanc. This monarch of mountains was supported by worthy attendants—peaks nearly rivalling him in height, but not in colossal proportions; for none of them had that majestic breadth and repose, which distinguishes this the highest mountain of Europe. We had attained an elevation of nearly ten thousand feet, but the summits before us numbered about five thousand more. The sun was shining brightly upon them, making every thing sharp and distinct, and adding greatly to the inexpressible vastness and solitude of the scene. While thus seated, two eagles suddenly appeared wheeling round in circles, hovering darkly

over us, and evidently looking out for prey; the marmot's shrill cry was sometimes heard from crevices in the rocks; and a few sheep, with beautifully white fleeces, came very near to beg for a supply of salt, which the guides are in the habit of giving them. These poor animals find a scanty pasturage on the wild mountains during a few weeks of summer; and in search of it, they sometimes fall over the precipices, or they meet with a more lingering death from starvation. Lower down there are some really fine pastures, grazed by cows in summer. They are transported over a very difficult part of the glacier, on a kind of rude pathway formed of planks; and about thirty peasants, aided by ropes, compel the poor animals to cross the bridges thus prepared for them.

After resting for about a quarter of an hour, we again started on the ascent, and, after some hard climbing, and a short descent, arrived at a valley still higher, and contributing its icy stream to swell the gelid current of the Mer de Glace. This is the glacier of Telèfre, and in the centre of it is a very large exposed surface of rock, of a triangular form, called the Jardin. To reach it, we had to cross the glacier, and this was the most difficult

and fatiguing part of the whole journey; for, being above the snow-line, the surface was covered with snow, into which we sank knee deep at every step. The sun was shining fiercely upon our backs, while our feet and legs were buried in snow—a strange contrast; but this heat explained the existence of a flower garden in these elevated regions. The triangular face of rock being fully exposed to the sun's rays, the snow is melted away during the short-lived summer, and the rough and shelvy surface becomes enamelled with Alpine flowers. After gathering some of the flowers, and taking another view of the magnificent prospect around us, we began to descend.

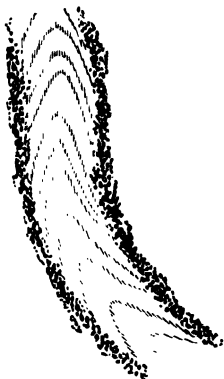
We were now near that part of the glacier, where are housed the stores of each winter for supplying the waste of the lower icy region. Here the snow, instead of melting, assumes a granular form, like rice or peas, and is called *firn* by the German peasants, and *haut névé* in French. As this névé slides lower down, and passes into complete ice, it assumes the transparency and colour of the proper glacier; but before this it has a greenish tinge; the warmth of the summer day commencing a thaw, which the cold of night soon terminates.

The névé has its crevices, but they are wider, and more irregular than those of the glacier, and the light transmitted by their walls is green instead of blue. "The substance is far more easily fractured than ice, and also more readily thawed and water worn; hence the caverns in the névé are extensive and fantastical, often extending to a great distance, under a deceptive covering of even snow, which may lure the unwary traveller to destruction. Sometimes, through a narrow slit or hole, opening to the surface of the névé, he may see spacious caverns of wide dimensions, over which he has been ignorantly treading, filled with hills of detached ice-blocks, tossed in chaotic heaps, while watery stalactites—icicles ten or twenty feet in length—hang from the roof, and give to these singular vaults all the grotesque varieties of outline, which are so much admired in calcareous caverns, but which here show to a far greater advantage, in consequence of their exquisite transparency and lustre, and from being illuminated, instead of by a few candles, by the magical light of a tender green, which issues from the very walls of the crystal chambers."

The descent of the glacier was much easier and

more rapid than the ascent. Before we reached the ice again, the sun had sunk behind some of the tallest peaks; and the vapour, which before had been made elastic and invisible by his rays, now began to condense, and to creep along the tops of the rocky walls, as slowly and gradually, as if a hand were letting down a curtain of gauze over the scene; but the tallest peaks continued for a much longer time to glow with a golden lustre, until at length, a mournful, blueish livid light prevailed, and gave a totally new aspect to the scene. The glacier also underwent a change; the wet slushy surface became hard and glassy, exposing the pedestrian to frequent falls; rills of water, which a very few hours before were sparkling in the sun, and hurrying to a lower level, had now disappeared altogether, or had shrunk in size; pools were edged with icy crystals; and every where the crackling sound of the feet told us that Frost was busy in asserting his dominion, and repairing the waste of a summer's day.

When the light is subdued, and the observer looks down upon the glacier from a height, a number of brownish bands are discovered in curves, bending downwards from the moraines, and appearing like



a succession of waves, some hundred feet apart. In these bands, Mr. Forbes saw a likeness to the lines into which froth or scum on the surface of a thick fluid would form themselves, if that fluid were allowed to flow down an inclined trough or basin. The curved form of these bands was evidently owing to the greater rapidity of the glacier at the centre than at the sides.

Mr. Forbes suspecting that the glacier was not a mass of solid ice, but a compound of ice and water, and therefore resembling, to a certain extent, a pitchy fluid, performed the following ingenious experiment :—Holes, about a foot square, were made to a small depth, in the most compact part of the ice, and some black and red liquid dyes were poured in. If the ice were solid and compact, these dyes would simply remain without being diffused ; but if the ice were of an imperfect spongy nature, infiltrated by water, the dyes

would evidently mingle with the water, and stain the ice to a great depth. After some hours a large block of ice, containing one of the holes, was cut out, when the colour was found to have infiltrated into the ice, beneath and around; thus proving that the pores of the ice are saturated with water, which does not freeze in summer, while the snowy covering of winter keeping the glacier warm, just as it does the ground, the ice below the surface is wet even in cold weather. In fact, the ice of the glacier is unlike that produced by the freezing of still water. It is composed of thin plates of compact, transparent, blue ice, and plates of a different colour, caused by innumerable air bubbles, which give a frothy appearance to the ice, and make it very brittle. It often happens that the action of the sun and rain thaws and wastes away the less compact ice; leaving the harder, bluer veins standing up in ridges, between which the sand of the moraines will lodge. This sometimes gives to the surface of the glacier the appearance of a road of stiff mud indented with cart ruts.

It has been already stated that the surface of the glacier is embarrassing to the traveller, and even to the guides, from the apparently endless

repetition of similar features. It is almost impossible to go twice over the same road on the glacier, and nothing is so easy as to get into a maze of crevasses, some of which are impassable. Our guides were several times perplexed; but were relieved by discovering some piles of stones which had been set up by the guides, who, the day before, had conducted some travellers to the Jardin. A sort of general route is marked out by the guides, and adhered to as much as possible; but the changeful nature of the glacier and its edging moraines renders it impossible to fix any thing like permanent land marks. And yet, amidst all this change, there is a certain steadfastness of form which is wonderful. Year after year, an experienced guide will appear to go in nearly the same path, avoiding the same crevasses, and pointing out the same moulins and other objects of interest, and yet, by the progressive movement of the glacier, the ice is wholly changed. The bed of the glacier and the rocks at the side remaining nearly always the same, the ice is twisted into the same forms, and hence appears to be at rest.

Such then is the glacier as we witnessed it in the Mer de Glace, which combines all, or nearly all,

the chief features of glacier scenery. The length of the whole Mer de Glace is said to be eighteen leagues; but a league is generally understood to mean an hour's walk among the mountains. According to Mr. Forbes's survey, the shortest line from the foot of the glacier to the highest ridge of the Alps is about seven miles, and the breadth of the glacier seldom exceeds two-thirds of a mile, but is generally much less. This, however, gives no idea of its apparent extent,—the toil of traversing it, and the endless turns among its crevasses, make an enormous addition to the distance.

On descending into the valley of Chamouny, blocks of moraine lie scattered here and there, forming a wilderness of stones of all shapes and sizes, showing how far the ice had in former years extended. And long after quitting the region of the glacier, huge stones, precisely similar to those seen on and about the ice, are to be met with indeed, they are scattered over many parts of Europe, and are hence called *erratic* or *wandering* blocks; they are also called *boulders*. A great belt of these stones extends for miles, at a height of about 800 feet above the level of the lake of Neufchatel. One of these blocks, situated about

two miles to the west of the town of Neufchatel, is called the *Pierre à Bot*, or the Toad-stone, from its rude resemblance to the form of a crouching toad. This stone is fifty feet long, twenty wide, and forty high, and contains about 40,000 cubic feet of solid material. It was suggested many years ago by Professor Playfair, that these erratic blocks were deposited by ancient glaciers, which have since retreated within narrower limits. Speaking of the Toad-stone, he says, "A current of water, however powerful, could never have carried it up an acclivity, but would have deposited it in the first valley it came to, and would, in a much less distance, have rounded its angles, and given to it the shape so characteristic of stones subject to the action of water. A glacier, which fills up valleys in its course, and which conveys rocks on its surface free from attrition, is the only agent we now see capable of transporting them to such a distance without destroying that sharpness of the angles so distinctive of these masses."

Another proof of the former existence of glaciers is to be found in polished rocks, which are seen many miles away from the site of any existing glacier. It has been already noticed, (p. 92) that the ice,

in creeping on, continually chafes and polishes its rocky walls or sides, and in time wears down the solid granite, and leaves the most decided proofs of its action.



THE TOAD-STONE.



ICE-BERG.

CHAPTER V.

ICE OF THE ARCTIC REGIONS—VARIOUS KINDS OF ICE—ICE-BLINK—
LOOMING, REMARKABLE INSTANCES OF—FORMATION OF HUMMOCKS
—DANGERS OF NAVIGATING THESE SEAS—ICEBERGS—THEIR GENERAL
FORM AND APPEARANCE—THEIR DANGERS—THEIR FORMATION.

The roar of winds and waves, the crush of ice,
Now ceasing, now renew'd with louder rage,
And in dire echoes bellowing round the main.

Thomson.

THE Arctic seas, and many parts of the North Atlantic Ocean, are peculiarly dangerous to the navigator, from the floating masses of ice which obstruct his course, and frequently beset him on every side. In high latitudes the seas are navigable only during the short summer. The first warmth of a summer's sun gradually melts or softens the icy floor, and the first strong wind, creating a swell in the ocean, breaks up the ice into vast *fields*, as they are called, some of which are several hundred square miles in extent. These being thus set afloat are, by the violence of the winds and currents, broken into *floes*, or smaller

fields, the size of which can be distinguished from the mast-head of a ship. When a field is broken into a number of pieces, not exceeding forty or fifty yards across, the whole is called a *pack*; when the pieces are broad, they are called a *patch*; and when long and narrow, a *stream*. These packs are often crowded and heaped together by the violence of the winds, but again separate in calm weather. When a ship can sail freely through these masses, the ice is said to be *loose* or *open*, and is called *drift* ice. When the ice is crumbled into small pieces, it is called *brash* ice. When a strong freezing wind blows over the surface of the ocean, the motion of the waves prevents solid ice from being at first formed, but the water is congealed into a spongy mass called *sludge*; this has the effect, to some extent, of stilling the waves, and it forms itself into small plates, which, being rounded by continual rubbing, are called *pancakes*, the edges of which are slightly raised by constant pressure. These cakes adhering together form a solid surface, which, under the influence of the frost, extends in every direction, until, at length, a field of ice is again formed.

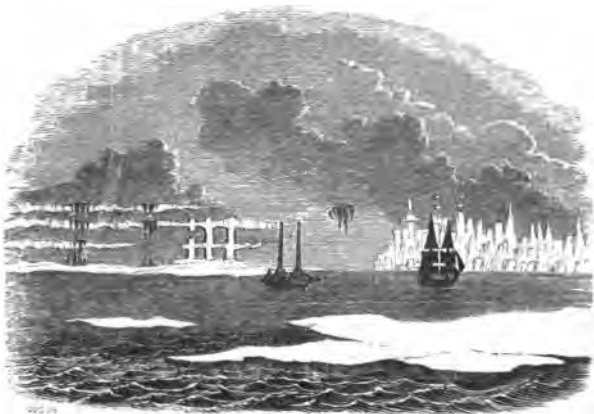
The presence of fields and other collections of

floating ice is often discovered at a great distance, by a singular appearance on the verge of the horizon, called *ice-blink*. It is a band of lucid whiteness, occasioned by the glare of light reflected obliquely from the surface of the ice against the opposite atmosphere. This shining streak, which looks always brightest in clear weather, points out to the experienced navigator, twenty or thirty miles beyond the limit of direct vision, not only the extent and figure, but also the quality of the ice. The blink from packs of ice appears of a pure white, while that occasioned by wide plains of snow has a yellowish tinge.

The ice-blink is very useful to seamen, for it often exhibits dark spots or patches, corresponding to certain openings of water, the existence of which could not otherwise be known; and when beset by ice, he endeavours to make his way in their direction. The ice-blink often produces an effect called *looming*, whereby objects near the horizon appear distorted and repeated, and often lifted up into the air. On one occasion, Mr. Scoresby having approached so near the unexplored shore of Greenland, that the land appeared distinct and bold, was anxious to make a drawing of it;

but on attempting to do so, he found the outline to be constantly changing. On examining the coast through a telescope, its appearance was that " of an extensive ancient city, abounding with the ruins of castles, obeliaks, churches, and monuments, with other large and conspicuous buildings. Some of the hills seemed to be surmounted by turrets, battlements, spires, and pinnacles; while others, subjected to one or two reflections, exhibited large masses of rock, apparently suspended in the air, at a considerable elevation above the actual termination of the mountains to which they referred. The whole exhibition was a grand phantasmagoria. Scarcely was any portion sketched before it changed its appearance, and assumed the form of an object totally different. It was, perhaps, alternately a castle, a cathedral, or an obelisk; then expanding horizontally, and coalescing with the adjoining hills, united the intermediate valleys, though some miles in width, by a bridge of a single arch, of the most magnificent appearance and extent. Notwithstanding these repeated changes, the various figures represented in the drawing had all the distinctness of reality; and not only the different strata, but also the veins of the rocks, with the wreaths of

snow occupying ravines and fissures, formed sharp and distinct lines, and exhibited every appearance of the most perfect solidity."



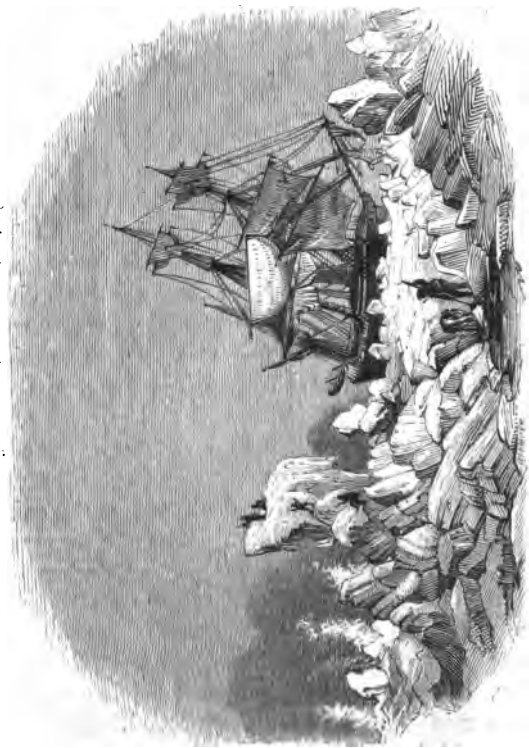
LOOMING OF THE ICE.

On another occasion, on the same coast, Mr. Scoresby saw an inverted image of a ship in the air, and on looking at it through his telescope, he could distinguish every sail, the general rig of the ship, and its particular character; "insomuch, that I confidently pronounced it to be my father's ship, the *Fame*, which it afterwards proved to be;

though, on comparing notes with my father, I found that our relative position at the time gave a distance from one another very nearly thirty miles, being about seventeen miles beyond the horizon, and some leagues beyond the limit of direct vision. I was so struck with the peculiarity of the circumstance, that I mentioned it to the officer of the watch, stating my full conviction that the *Fame* was then cruising in the neighbouring inlet."

In some cases, these aerial reflections are repeated two, three, and even four times; the form of a ship, for example, appearing in the air; then above this the same object inverted; then the third occurs in its right position, and the fourth is inverted.

The surface of the ice in the Arctic regions is by no means so level as we are accustomed to see it in our own temperate climate. The enormous fields of ice, once set afloat, are by the violence of winds and currents driven about, and sometimes approaching in opposite directions, strike against each other with the force of millions of tons, the effect of which is to squeeze up one piece over another above the common level, and to form what are called *hummocks*. These hummocks relieve the dull uniformity of the ice, and often present a most



SHIP THROWN UP BY THE ICE.—FROST SMOKE IN THE DISTANCE.

fantastic appearance, rising in a variety of shape to the height of perhaps thirty feet. They are most numerous in the heavy packs, and along the edges of ice-fields.

It is awful to contemplate the situation of a ship exposed to these moving masses of ice. It may either be crushed like a thing of naught, or, by a more merciful Providence, lifted completely out of the water, by the pressure of two opposing masses, and placed high and dry upon the ice. The ships engaged in the northern whale fishery are accustomed to dangers such as these. Captain Scoresby has witnessed the effects produced by the motion of these floating masses. On one occasion, passing between two fields of ice, newly formed, about a foot in thickness, they were observed rapidly to approach each other, and before the ship could pass the strait, they met. The one overlaid the other, and presently covered many acres of surface. The ship standing in the way, the ice was squeezed up on both sides, shaking the ship in a dreadful manner, and producing a loud, grinding, or long, sharp, trembling noise, according as the pressure was diminished or increased, until the ice rose as high as the deck. This continued for



SHIPS BESET BY ICE.

about two hours, when the motion ceased, and soon afterwards the two sheets of ice receded from each other. The ship in this case did not receive any injury, but the captain is of opinion, that had the ice been only half a foot thicker, she must have been wrecked.

But in these northern seas the ice assumes a yet more tremendous form. Floating mountains of ice, called *icebergs*, are constantly moving about, and are sometimes so numerous, as to hem in a ship for days and weeks together, threatening it with destruction. Some of these icebergs rise 150 feet above the surface of the water, and as, from their weight, not more than a seventh or an eighth part is ever visible, their absolute height must be 900 or 1,000 feet. With this enormous height, they are often more than a mile in circumference ; and as they float in the sea, exposed to the melting influence of the waves and currents, and are wafted into the warmer regions of the Atlantic, they assume a variety of strange forms. Some resemble palaces, churches, or old castles, with spires, towers, windows, and arched gateways of the purest marble, or, when lit up by the sun, of the finest silver. Others appear like ships, trees,

animals, or human beings—the productions of some gigantic sculptor. When seen from the distance of a few miles, they have very much the appear-



ICE-BERG SEEN IN BAFFIN'S BAY.

ance of a mountainous country. Their colours are also extremely beautiful; some brilliant as burnished silver, others reflecting the colours of the rainbow—bright green, blue, and orange being the prevailing tints; and even at night their lustre enables them to be distinguished from afar. But

it is only from a distance that they are regarded with admiration. On approaching them, the air is felt to be cooled by their presence, a circumstance which frequently warns the navigator by night of his danger; but sometimes the whalers seek the shelter of an iceberg from the violence of the gale, and also from the other descriptions of ice which float past with considerable speed, while, from its vast size and depth in the water, the iceberg moves but slowly. There are, however, some dangers to a ship in being moored to the frozen cliff; large fragments of ice, from the under part of the mass, frequently dart up to the surface, and often strike holes in the ship's bottom; projecting points, a little below the surface, may also pierce the planking; the strong current which generally runs along the side of an iceberg may dash the vessel against it. But, perhaps, the greatest danger arises from the circumstance, that an iceberg is generally so nicely balanced in the water, that if a large piece breaks off on one side, the whole mass will suddenly turn over, and stave or wreck the vessel, producing at the same time vast waves to a considerable distance around, sufficient to overwhelm all smaller craft.

In the winter of 1836-7, H. M. S. *Terror* was frozen into a large floe of ice in Baffin's Bay, and continued drifting about during several months. On the breaking up of this floe during the following summer, the ship was discovered to be attached to a sunken iceberg, which, on rising, threw the ship on her beam ends, to the great dismay of all on board. By the diligent use of the ice-saw the ponderous incumbrance was cut away, but not without great damage to the ship, some idea of which may be formed from the vignette at the end of this chapter.

The swell of the sea causes the bergs to rise and fall with a tremendous noise; but is far less effectual in breaking them up than the heat of the sun. Few of the icebergs are destroyed in the Arctic seas, but they are brought down by currents into the Atlantic, where, by the action of heat and the warmer water, they become hollow and rotten; large pieces fall off; the masses roll over and over, until at length they fall entirely asunder, producing a noise of equal effect to thunder, and launching forth huge waves, which travel for miles, breaking up the fields and floes of ice, checking the dominion of the frost, and preventing the ice of the Arctic regions from accumulating.

The icebergs afford retreat to a great number of seals, which are thus floated, in the month of March, off the coasts of Newfoundland; and a



SWELL AMONG ICE.

dangerous, but profitable fishery, has, of late years, been established, by sending out vessels in pursuit of the seals on these icy masses. Foxes, bears, and other animals are annually transported on similar icy carriages from one country to another; and even herbs and pine saplings have thus been trans-

planted to distant shores, where they have continued to vegetate after the ice which conveyed them has melted away.

Icebergs contain many deep cavities, which are filled with the purest and most refreshing water, often flowing over the edges in beautiful cascades. Vessels in want of fresh water often obtain it from this source. The water-casks are either landed, filled, and then rolled into the sea; or, they remain in the boat, or even on the deck of the ship, and the water is conveyed into them by means of a long tube of canvass or leather.

The origin of these mighty masses of ice is to be found in the glaciers which fill the polar valleys, most of which, so far as they are known, open at once into the sea. The Alpine glaciers, described in the last chapter, run into valleys which terminate on dry land, where the increasing warmth prevents their further progress. The glaciers of polar valleys extend down steep banks into the sea, where they are slowly corroded by the salt water; the ice still pressing on from behind, the projected mass can no longer support its own weight; it snaps off and plunges into the deep, where it splits into several pieces, forming as many icebergs.

The shores of Greenland are so beset with ice, that, in many places, it is quite impossible even for a boat to find a landing.

The Greenlanders call this launching of an iceberg, the *calving of the ice-blink*; and Mr. Scoresby was once so fortunate as to witness it. "A strong north-westerly swell having for some hours been breaking on the shore, had loosened a number of fragments attached to the iceberg, and various heaps of broken ice denoted recent shoots of the seaward edge. As we rowed towards it, with a view of proceeding close to its base, I observed a few little pieces fall from the top; and while my eye was fixed upon the place, an immense column, probably fifty feet square, and one hundred and fifty feet high, began to leave the parent ice at the top, and, leaning majestically forward, with an accelerated velocity, fell, with an awful crash, into the sea. The water into which it plunged was converted into an appearance of vapour, or smoke, like that from a furious cannonading. The noise was equal to that of thunder, which it nearly resembled. The column which fell was nearly square, and in magnitude resembled a church. It broke into thousands of pieces."

Almost every iceberg, like every glacier, is covered with masses of stone from the size of a walnut to that of a house. As the iceberg melts, these stones are deposited in various parts of the ocean, and resemble the boulder stones which have been left in places from which glaciers have long receded.



THE KEEL OF H. M. S. TERROR, DAMAGED BY THE ICE.



W. H. W. & C.

BREAKING UP OF THE ICE.

CHAPTER VI.

THE BREAKING UP OF FROST—THE EISGANG—THAWING OF THE NEVA
—BREAKING UP OF THE ICE ON THE CANADIAN LAKES—THE GROUND
SWELL—PENKNIFE-ICE—CUTTING OUT—ICE-SAWS.

Muttering, the winds at eve, with blunted point,
Blow hollow blustering from the south. Subdued,
The frost resolves into a trickling thaw.
Spotted the mountains shine; loose sleet descends,
And floods the country round. The rivers swell,
Of bonds impatient. Sudden from the hills,
O'er rocks and woods, in broad brown cataracts,
A thousand snow-fed torrents shoot at once;
And, where they rush, the wide-resounding plain
Is left one slimy waste.

THE breaking up of frost is seldom attended with any very remarkable effects in this country; but in those ice-bound lands, where the cold has full sway for several months of the year, the case is very different. In the following description we, have a vivid picture of the breaking up of ice on the shores of the Baltic:—

“ The soft hand of spring imperceptibly withdraws the bolts and bars of winter, while the earth,

like a drowsy child 'twixt sleeping and waking, flings off one wrapper after another, and opes its heavy lids in showers of sweet rivulets. And the snow disappears, and the brown earth peeps almost dry from beneath; and you wonder where all the mountains of moisture are gone. But wait;—the rivers are still locked, and though a strong current is pouring on their surface, yet, from the high bridge, the green ice is still seen deep below, firm as a rock; and dogs go splashing over in the old track; and peasants, with their horses, venture long after it seems prudent. At length a sound like distant thunder, or the crashing of a forest, meets your ear, and the words "*der Eisgang, der Eisgang!*"* pass from mouth to mouth; and those who would witness this northern scene, hurry out to the old stone bridge, and are obliged to take a circuitous route, for the waters have risen ankle deep. And then another crash, and you double your pace, regardless of wet feet: and are startled at the change which a few hours have produced. On the one side, close besetting the bridge, and high up the banks, lies a field of ice, lifting the

* Literally, "the ice-going," which is not fully expressed by the English word "thaw."

waters before it, and spreading them over the country, while huge masses flounder and swing against one another with loud reports, and heave up their green transparent edges, full six feet thick, with a majestic motion ; and all these press heavily upon the bridge, which trembles at every stroke, and stands like a living thing, labouring and gasping for breath through the small apertures of the almost choked arches. On the other side, the river is free of ice ; and a furious stream, as if all the waters of Russia were let loose, is dashing down, bearing with it some huge leviathan of semi-transparent crystal, and curdling its waters about it, till this again is stopped by another field of ice lower down.

“ The waters were rising every minute—night was approaching, and the beautiful old bridge gave us great alarm, when a party of peasants arrived to relieve it. Each was armed with a long pole with an iron point, and flying down the piles, and on to the ice itself, began hacking at the sides of the foremost monster, till, impelled by the current beneath, it could fit and grind itself through the bridge, and gallop down to thunder against its comrades below. The men were utterly fear-

less, giving a keen sense of adventure to their dangerous task which rivetted us to the spot; some of the most daring standing and leaning with their whole weight over the bed of the torrent, upon the very mass they were hewing off, till the slow swing which preceded the final plunge, made them fly to the piles for safety. Some fragments were doubly hard, with imbedded stones and pieces of timber; and no sooner was one enemy despatched, than another succeeded; and although bodies of men continued relieving each other all night, the bridge sustained such damage as could not be repaired. All was over in twelve hours; but meanwhile 'the waters prevailed exceedingly upon the earth,' and every hill and building stood insulated."

The cutting and storing of the ice of the Neva has already been noticed, (page 61.) About the beginning of April the inhabitants eagerly look forward to the moment when their beloved river will burst her bonds. As soon as the icy mass begins to move, the glad tidings are announced to the expectant capital by the artillery of the citadel, a fortress of considerable strength, situated immediately opposite to the emperor's palace. The

very moment, be it day or night, that an open interval occurs between the floating masses of ice, the governor of the citadel crosses in a boat to the palace, and presents his Majesty with a crystal goblet, full of Neva water, as the first offering of the returning spring ; and this goblet the emperor drinks off to the health and prosperity of his capital. It was customary, till within the last few years, for the emperor to fill the empty goblet with gold, and return it to the governor ; but it was noticed that the goblet grew larger and larger every year, so that the task of emptying the glass became yearly more difficult of accomplishment, while, on the other hand, it required every year a greater number of ducats to fill it. But his Majesty has of late reduced the customary present to the governor, who now receives 200 ducats in return for his simple beverage. This sum, though less than his predecessors have frequently received, is still, perhaps, a larger price than is paid for a glass of water in any other part of the world.

The breaking up of the ice is sometimes occasioned by the powerful mechanical force of wind or water, even while the frost continues, as in the

following instance recorded by Major Head, as witnessed on one of the Canadian lakes :—

“*March 7.*—The frost continued, and the cold increased to a very low temperature, the effect of which upon the extended sheet of ice, which covered the bay, was somewhat remarkable. It cracked and split from one end to the other, with a noise that might have been mistaken for distant artillery; but this, when it is taken into consideration that the sheet of ice was fifteen or sixteen square miles in area, and three feet thick, may be easily imagined. Nor was this all: I was occasionally surprised by sounds produced by the wind, indescribably awful and grand. Whether the vast sheet of ice was made to vibrate and bel- low like the copper which generates the thunder of the stage; or whether the air, rushing through its cracks and fissures, made a noise, I will not pretend to say; still less to describe the various intonations which in every direction struck upon the ear. A dreary undulating sound wandered from point to point, perplexing the mind to imagine whence it came, or whither it went, and whether aerial or subterranean; sometimes like low moaning, and then swelling into a deep-toned

note, as produced by some Æolian instrument, it being in real fact, and without metaphor, the voice of winds imprisoned in the bosom of the deep."

The partial breaking up of the ice in Arctic regions, is often attended with great danger to the inhabitants. A party of Moravian Missionaries were crossing an arm of the sea, on the coast of Labrador, on sledges drawn by dogs. The first alarm was given by some passing Esquimaux, and afterwards by their own attendants; but no danger was apparent, except, on lying down, a hollow grating sound was heard beneath the ice. Presently the wind rose to a storm, and the swell had increased so much, that its effects on the ice were alarming. "The sledges, instead of gliding smoothly along, as on an even surface, sometimes ran with violence after the dogs, and sometimes seemed with difficulty to ascend a rising hill. Noises too were now distinctly heard in many directions, like the report of a cannon, from the bursting of the ice at a distance. Alarmed by these frightful appearances, our travellers drove with all haste toward the shore; and as they approached it, the prospect before them was tremendous. The ice having

burst loose from the rocks, was tossed to and fro, and broken in a thousand pieces, against the precipices, with a dreadful noise ; which, added to the raging of the sea, the roaring of the wind, and the driving of the snow, so completely overpowered them, as almost to deprive them of the use both of their eyes and ears. To make the land was now the only resource that remained ; but it was with the utmost difficulty that the frightened dogs could be driven forward ; and, as the whole body of the ice frequently sank below the summits of the rocks, and then rose above them, the only time for landing was the moment it gained the level of the coast,—a circumstance which rendered the attempt extremely nice and hazardous. Both sledges, however, succeeded in gaining the shore, though not without great difficulty. Scarcely had they reached it, when that part of the ice, from which they had just escaped, burst asunder, and the water, rushing up from beneath, instantly precipitated it into the ocean. In a moment, as if by a signal, the whole mass of ice, for several miles along the coast, and extending as far as the eye could reach, began to break, and to be overwhelmed by the waves. The spectacle was awfully

grand. The immense fields of ice rising out of the ocean, clashing against one another, and then plunging into the deep with a violence which no language can describe, and a noise like the discharge of a thousand cannon, was a sight which must have struck the most unreflecting mind with solemn awe. The brethren were overwhelmed with amazement at their miraculous escape, and even the pagan Esquimaux expressed gratitude to God for their deliverance."

In the attempt to reach the North Pole in boats, Captain Parry noticed a curious form of ice. It was composed on its upper surface, "of numberless irregular needle-like crystals, placed vertically, and nearly close together; their length varying, in different pieces of ice, from five to ten inches, and their breadth in the middle about half an inch, but pointed at both ends. The upper surface of ice having this structure, sometimes looks like greenish velvet; a vertical section of it, which frequently occurs at the margin of floes, resembles, while it remains compact, the most beautiful satin-spar, and asbestos when falling to pieces. At this early part of the season, this kind of ice afforded pretty firm footing; but as the summer

advanced, the needles became more loose and moveable, rendering it extremely fatiguing to walk over them, besides cutting our boots and feet, on which account the men called them 'penknives.'" Captain Parry thought it probable that these sharp points were formed by the heavy drops of rain piercing their way downward through the ice, and thus separating it into needles.

Such are the general effects of a thaw in northern regions; but it sometimes happens that, after the severity of winter is past, the harbours long remain frozen over, and vessels, in order to be launched into the sea, must have a passage cut for them through the ice. Such is the case in the harbours of Newfoundland, where the crews of the numerous vessels engaged in the seal-fishery unite to cut with ice-saws a broad channel to the open sea. The scene is described by an eye-witness as being of the most animated kind, the labourers being sometimes as many as two thousand, and the vessels upwards of a hundred in number. When the channel is completed, and each craft has made good its passage into it, the vessels, arranged in single file, with canvass set, and flags flying, sail

down before the breeze, and are soon scattered over the face of the ocean.

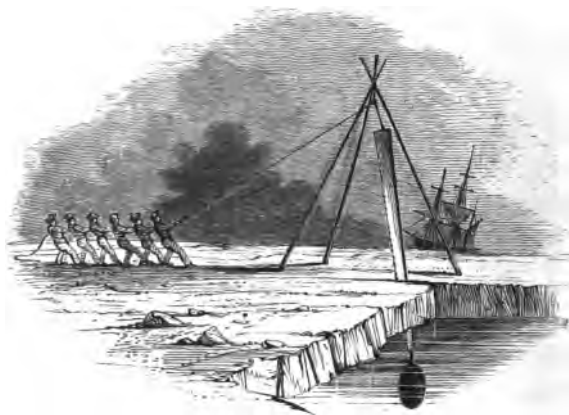


A CUTTING-OUT.

View of the harbour of Carbonear, Newfoundland.

Ice-saws are not only of use in the above cases, but the vessels employed in the Greenland fisheries, and others that navigate the Polar Seas, are furnished with them, for relieving ships from a very dangerous position. The lives of the crew often depend on the rapidity with which a passage can

be cut, so as to disengage the vessel before the accumulation of ice renders it impossible to do so. The saw is similar to that used in cutting timber, and has a weight suspended to it. This is intro-



THE ICE-SAW.

duced through a hole in the ice, broken for the purpose, and is suspended by a rope, passed over a pully fixed to a triangle. A party of a dozen or more men run out and back again with a rope, and

thus move the saw up and down, by which means it cuts its way, the triangle being moved forward from time to time. The services of the whole crew are usually required in this laborious work.

The nature and uses of ice have thus been briefly traced. As the reservoirs of mighty rivers, the protective covering of streams, the grand and effective agent by which rocks are rent asunder, forests upturned, and stubborn soils improved, this beautiful substance rises in importance, and appears more clearly as the ordained means of good to the earth. In the sublime language of the Psalmist, all Nature is called upon to "praise the Lord;" the inanimate as well as the animate creation—"fire and hail, snow and vapours, stormy wind fulfilling his word." "He giveth snow like wool; He scattereth the hoar-frost like ashes; He casteth forth his ice like morsels. Who can stand before his cold? He sendeth out his word and melteth them; He causeth his wind to blow, and

the waters flow." (Psalm cxlvii. 16—18.) And if these inferior agencies bring glory to their Creator, much more should His intelligent and accountable creatures unite to praise Him. "Both young men and maidens; old men and children; let them praise the name of the Lord; for His name alone is excellent; His glory is above the earth and heaven." (Psalm cxlviii. 12, 13.)

THE END.

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